November, 1978
Price, $2.00

Technology Review

Edited at the Massachusetts Institute of Technology

Naked-Eye Astronomy in the New World

Health Effects of Ionizing Radiation
Technology for Human Rehabilitation
Science in the People's Republic of China
Tidal Power in the Bay of Fundy

technology
review
Published by MIT

BUSINESS IS CHANGING THE WAY IT DOES BUSINESS.

It's been said that you could take a 19th-century clerk, put him in a 20th-century office, and he'd have very little trouble adapting.

That's because while technology was leaping into almost every other area of business, it was barely creeping into the office.

Leaving offices underequipped to handle the 72 billion new documents that arrive yearly.

But all that's changing now. Technology is finally finding its way into the office.

And at Xerox, it's our business to help you manage that change.

Not just with better copiers and duplicators.

But with electronic typing systems that let you create, edit and store information. Telecopier transceivers that transmit it.

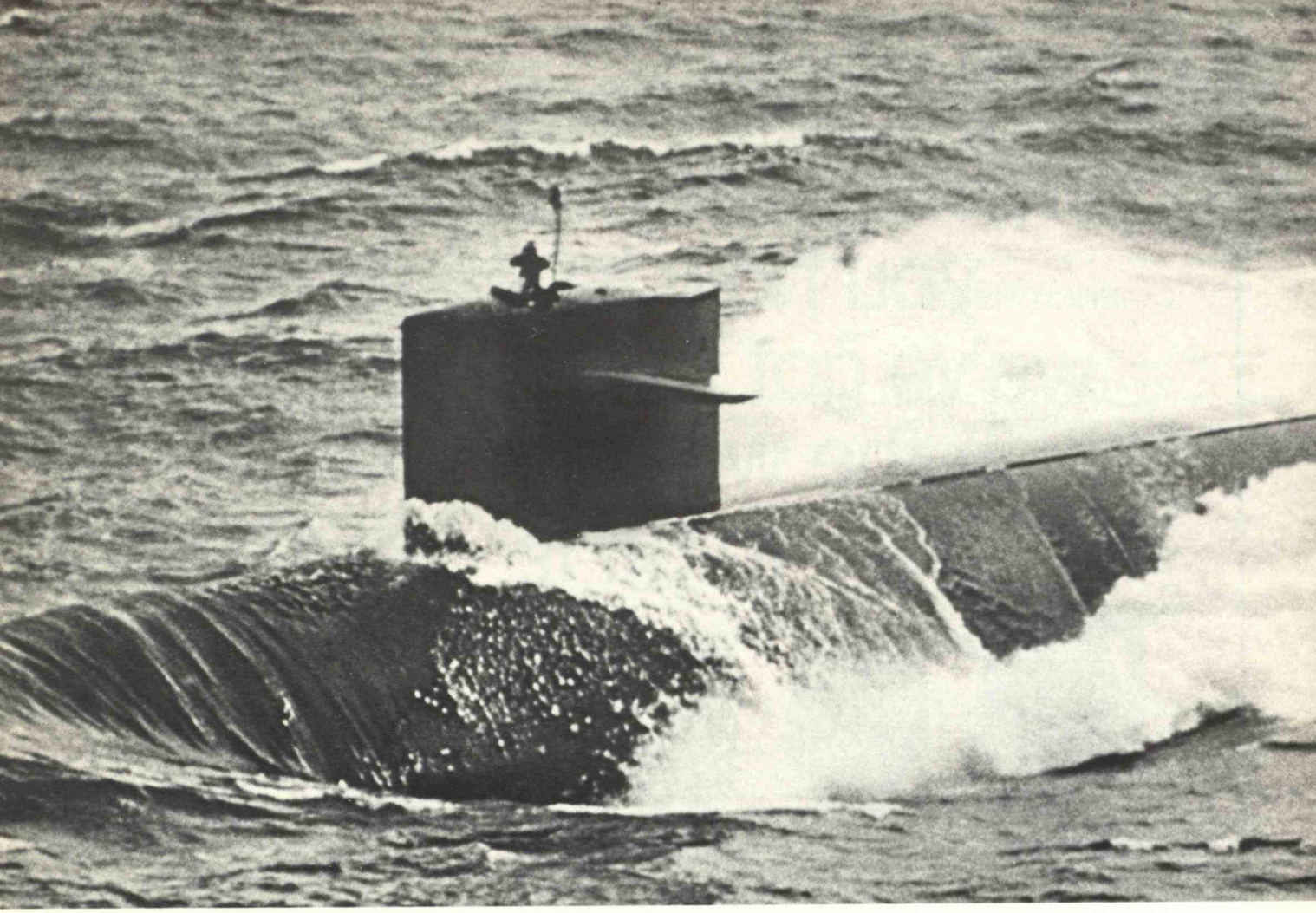
Computer services that give you the benefits of a computer without having to own one.

Even electronic printers that let you take information directly from a computer—and then print it out in all the ways you want it.

By designing systems to help businesses manage information, Xerox is actually doing something even more important:

Namely, helping offices leap right into the present.

XEROX



HERE'S ONE ENGINEERING OPPORTUNITY YOU WON'T GET IN PRIVATE INDUSTRY.

If you're thinking about a technical position after graduation, think about this.

How many companies can offer you a nuclear submarine to operate? The answer is none. Equipment like this is available only in one place – the Navy.

The Navy operates over half the nuclear reactors in America. So our training is the broadest and most comprehensive. We start by giving you a year of advanced technical education. In graduate school, this would cost you thousands, but in the Navy, we pay you.

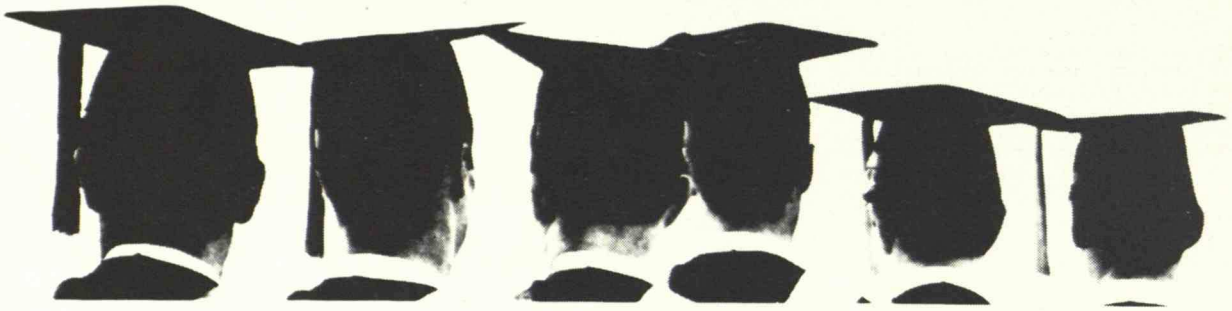
Once you're a commissioned Nuclear Propulsion Officer, you'll earn a top salary. Over $24,000 a year after four years. And you'll be responsible for some of the most advanced equipment developed by man.

The Navy also has other opportunities in surface ships and aviation assignments. If you are majoring in engineering, math or the physical sciences, contact your placement office to find out when a Navy representative will be on campus. Or send your resume to: Navy Officer Programs, Code 312-B530, 4015 Wilson Blvd., Arlington, VA 22203.

The Navy. When it comes to nuclear training, no one can give you a better start.

NAVY OFFICER. IT'S NOT JUST A JOB, IT'S AN ADVENTURE.

If college has really taught you how to think, we've got the best place in the world for you to do it.



At GTE Automatic Electric Laboratories brand new facility in beautiful sunny Phoenix, you'll work with one of the finest research and development teams in the country, designing digital telecommunications equipment for today and for the future. You'll add your brains to some of the nation's most brilliant, and have the freedom you need to create and grow — both personally and professionally.

It's truly one of the best living/working combinations imaginable; and the best way to begin your professional career.

Currently we are seeking professionals educated in the following disciplines:

SOFTWARE DESIGN

APPLICATIONS SOFTWARE. Large scale development in telephone system real-time control.

Maintenance and fault recovery software, administrative software involving real-time data base administration, switch and network management software, as well as operating system/executive software.

SUPPORT SOFTWARE. Involved in compiler, assembler and simulator development, as well as system utilities and software development tools. Support effort is related to large IBM processors, micro-processors, and mini computers systems.

DATA BASE SOFTWARE. Responsible for logical and physical data base design and implementation related to telecommunications systems. Develop programs which automate the generation of data base contents for these systems.

SOFTWARE/HARDWARE DESIGN

Specify, design and test digital logic hardware and diagnostic software. Develop maintenance facilities to detect and correct present and latent hardware and software faults. Develop programs for common control diagnostics and recovery and diagnostic programs for peripheral equipment and maintenance support programs.

SYSTEMS CONTROL & TESTING

Development and execution of comprehensive test plans to evaluate the performance of large stored program switching systems. Execute configuration management on all hardware, software, and documentation and maintain project control for all activities. System evaluation and test performed on both laboratory prototypes and initial field site locations.

We offer an excellent salary/benefit package (including hospitalization, major medical, dental, relocation assistance, disability and life insurance; pension and credit union) modern facilities and a climate conducive to personal and professional growth. If you possess a minimum of a BS, Electrical Engineering, Computer Science or any other appropriate engineering discipline, please send resume in confidence to:

Manager of Recruiting, Department ECM
GTE AUTOMATIC ELECTRIC LABORATORIES
11226 North 23rd Avenue, Phoenix, Arizona, 85029

GTE AUTOMATIC ELECTRIC LABORATORIES

We are an equal opportunity employer m/f.

Edited at the Massachusetts Institute of Technology

Volume 81, Number 2
November, 1978

Technology Review

Technology Review, Reg. U.S. Patent Office, is published eight times each year (in June/July, August/September, October, November, December/January, February, March/April, and May) at the Massachusetts Institute of Technology; three special editions are provided for graduate (pp. A1-A16) and undergraduate (pp. A1-A16 and B1-B16) alumni of M.I.T. Entire contents copyright 1978 by the Alumni Association of the Massachusetts Institute of Technology. *Technology Review* is printed by The Lane Press, Inc., Burlington, Vt. Second class postage paid at Boston, Mass., and at additional mailing offices.

Inquiries regarding editorial contents, subscriptions, and advertising should be addressed to: *Technology Review*, Room 10-140, Massachusetts Institute of Technology, Cambridge, Mass., 02139. Telephone: area code (617) 253-8250. Unsolicited manuscripts are welcome, but no responsibility for safekeeping can be assumed.

Price: $2 per copy. Subscriptions: in the U.S., $15 one year,, $24 two years, $32 three years. Add $2 per year for Canadian subscriptions. Mexico and overseas $23 one year, $38 two years, $50 three years. Please allow six weeks for changes of address and give both old and new addresses in all requests.

Back issues are $2.50 each for U.S.A. and Canada ($3.00 foreign). Reprints of certain articles are also available.

Technology Review is a member of the Audit Bureau of Circulation

Publisher
James A. Champy

Board of Editors
John I. Mattill *(Editor)*, Sara Jane Neustadtl, Michael Feirtag, Leonard A. Phillips, Marjorie Lyon, Susanne Fairclough, Sandra Knight

Art Director
Nancy C. Pokross

Production and Design Manager
Kathleen B. Sayre

Production and Editorial Assistant
Gunilla Levenson

Circulation and Promotion Manager
Evelyn R. Milardo

Subscription and Customer Service
Dorothy R. Finnerty

Articles

Departments

The Atomic Bond.

Using tiny explosive charges, Western Electric engineers are bonding metals with the elemental "glue" of the Universe.

Here's how it works. The atoms of all metals have a natural attraction for one another. If it weren't for the ever-present film of impurities coating the surface—the oxides, nitrides, and absorbed gasses—all metal atoms would bond to each other when brought together.

Exploding Things Together.

But the force of a high-intensity explosion on two adjacent metals will clean away the film of impurities. The explosion literally "blows" the impurities off the surfaces. So the atoms of the different metals can bond together.

The bond that results is stronger than both of the metals themselves.

As an industrial technique, explosive bonding has proved valuable in the manufacture of such heavyweight products as bi-metallic gun barrels.

Pinpoint Explosions.

But how would explosives work in the delicate, intricate world of telephone circuitry?

Scientists at Western Electric's Engineering Research Center solved the problem by developing ways to miniaturize and control explosive bonding. Soon, they could splice the ends of two thin communications wires inside a miniature explosive-coated sleeve.

And they could repair tiny defective contacts on delicate circuit boards. These gold contacts (membrane-thin "fingers" 1/10 by 3/4 of an inch) are reclad by thin sheets of gold foil (.0005 inches thick), coated with explosives. The repairs are literally "blown" onto the contacts, without disturbing the delicate circuitry less than 1/10 of an inch away.

Miniaturized explosive bonding is only one way we're helping your Bell Telephone Company hold down the cost of your telephone service today. For the future, it promises the benefits of bonding widely disparate metals and all sorts of other materials.

You Can Take It For Granted.

Most important, explosive bonds are contributing to the clarity of communications, the reliability of switching, the taken-for-granted assurance you have when you reach for your telephone.

The atomic bond—it's another innovation from Western Electric.

Keeping your communications system the best in the world.

Western Electric

The "Politics" of Bureaucracy

There are any number of reasons why Warren G. Bennis may already be a name familiar to our readers. Dr. Bennis's professional career began at M.I.T., where he studied and later taught what was then called "industrial psychology." Then he turned to practicing what he had been teaching as an administrator at the State University of New York at Buffalo and later as President of the University of Cincinnati. Now he is in the midst of a year of self-exploration, and we rejoice that he has offered to share some of that experience with us in the series which begins on page 11 of this issue.

In remarks to the Public Affairs Council early this fall, Dr. Bennis described himself as "a scholar of bureaucracy" in his early career. His experience at the helm of two major universities gave him special insight into what he calls "the 'politics' of bureaucracy — the poorly-understood problem of how our institutions interact with their environment and how these external forces regulate, more and more, internal operations."

Then Dr. Bennis went on, "People who have a difficult time communicating to others often have a difficult time communicating with themselves. . . . [And] institutions are even more complicated. To communicate clearly to external audiences, the institution has to possess a fair amount of understanding of itself and belief in its incumbents. . . . What is happening in many institutions is that the leaders are sitting back with wet palms doing nothing rather than taking a risk. That, to me, is the real danger of not understanding the new politics."

Some of this reminds us of the very popular article which Dr. Bennis contributed to the *Review* in March/April, 1977: "Where Have All the Leaders Gone?" (*Reprints are available from the Editors.*) We're confident that readers will share our pleasure in welcoming Dr. Bennis as a regular contributor to the *Review*'s 81st volume.

fi Versus fi

Careful readers of this issue who are also versed in the fine arts of typography may note some inconsistency in — and the general absence of — ligatures. (For other readers, a word of explanation: in traditional typesetting, some characters frequently associated with each other and whose form causes awkward blanks in the line are run together; fi [fi], fl [fl], and ae [æ] are examples.) The ligatures in *Technology Review* are a (temporary) victim of technological change: for the first time, most of the typesetting for this issue was originated on a keyboard in Cambridge, the impulses from this keyboard being transmitted by telephone to our printer's typesetters in Burlington, Vt. The technology is radical only from our point of view, but that in no way lessens its impact on our operations; and in devising our various signals and codes, the matter of ligatures was postponed as being of importance secondary to such matters as spelling, punctuation, italics, indentations, and the like. If readers are unable to detect other typographical irregularities in this issue, then all concerned will rejoice.

A New Visual Partnership

Our cover last month (*above*) was credited to Nancy C. Pokross, designer; we should also have mentioned Ralph Mercer, photographer, and some further words are due about each.

In the case of Mr. Mercer, words of apology, since we failed to note his contribution in our table of contents. Mr. Mercer is a free-lance photographer of some fortitude: he flinched hardly at all when confronted with Ms. Pokross' assignment of a color photograph combining computer circuitry and eye.

In the case of Ms. Pokross, words of welcome: she has joined *Technology Review*'s masthead as Art Director. The change is overdue, in the sense that Ms. Pokross — she is a member of the M.I.T. Design Services — has been contributing ever more to the *Review* since she first designed a cover for our issue of October, 1976. Now she and Kathleen Sayre, our Production Manager, have formed a full partnership to bring editors' words an accompaniment of informative illustration and appealing visual imagery.

Ms. Pokross came to M.I.T. in 1974 from Boston's public television station WGBH, where she had contributed for three years to that station's widely admired graphics. She studied at Simmons College, winning the Wrightson Award for Achievement in Graphic Design (1971). Her posters and other work for M.I.T. have been exhibited in many shows, and three of her covers for the *Review* have been honored by the Council for the Advancement of Higher Education and the University and College Designers Association. — *J.M.*

Symbol, Substance, and the Moral Economy

Kenneth E. Boulding is Director of the Institute of Behavioral Science and Professor of Economics at the University of Colorado at Boulder. He is a regular contributor to Technology Review

The moral economy is that segment of the world's social system in which individuals' decisions and actions are dominated by their image of the general good, even at some cost to their individual economic welfare. Cynics may argue that this constitutes a minor part of the social system and that most actions arise from an individual's economic interest. I disagree. Even in those activities which we think of as primarily economic — buying, selling, earning wages, making profits — behavior is at least limited by strong boundaries of moral taboo which we often take so much for granted we are unaware of them. The practice of simple honesty, for instance, even when it cannot be proved to be the best policy, is an astonishingly common human trait.

When it comes to political action the moral economy is dominant, for only this gives political action, legislation, and law, the legitimacy without which it cannot function. A significant amount of legislation derives from the dynamics of the moral economy of the preceeding two or three decades. Prohibition, environmental legislation, and the civil rights and anti-discrimination movements emerged into political action out of the moral economy. In socialist societies, also, the legitimacy of the political structure must rest on an underlying moral economy, though in each society the moral economy is somewhat different.

I call the moral economy an "economy" advisedly, in that it exhibits that flexible scarcity which is characteristic of all economies. Moral activity, especially for political ends, has limits. These limits may expand as moral indignations are aroused and they contract as acquiescence produces apathy. These contractions and expansions themselves are subject to limits. Where there are limits there is scarcity. Moral activity devoted to one object must be withdrawn from another.

Moral Pathologies

Alternative costs must be weighed in the moral economy just as in any other economy. This leads to a fundamental principle that it is never enough to show that something is either bad or good, one must also demonstrate that some feasible alternative is either better or worse. Pathologies of the moral economy frequently arise from the neglect of this principle. Thinking that proving something is bad is a sufficient argument against it or that proving something is good is a sufficient argument for it, is a common source of moral ineffectiveness, as it tends to direct moral feeling to inadequate ends.

The pathology of the moral economy may be defined as those situations in which activity designed to make things better actually makes them worse. Pathologies also arise from another principle: that it seems to be much easier to hate evil than to love good. These are not equivalent. There is evidence that the hatred of evil is a sharper spur to activity than the love of good, which often tends to be bland and diffuse. But an all consuming hatred of evil, however, often produces an even worse evil than that it intends to abolish. When people only know what they don't like but do not know what they do like, this leads to personality disorders, factionalism, and a wasteful use of moral resources. We could postulate an optimum mix, with enough hatred of evil to spur action, and enough love of good to make that action wise. But where this optimum lies in particular cases is ambiguous. I am pretty sure that revolutionaries tend to hate evil too much and love good too little; and conservatives perhaps love good, especially the established good, too much and hate evil too little.

Another danger to which the moral economy is subject is the confusion of symbol and substance. Moral feeling and action are aroused by appropriate symbols, such as the cross, the crescent, the flag, the sanctity of the home, the family farm, independence, free enterprise, building socialism, the four freedoms, human rights, democracy, liberty, equality, fraternity, the Immaculate Conception, the "Little Red Book," the swastika — the list resounds with overtones of both agony and ecstasy.

A great dilemma of the human race is that it is symbols and metaphors which inspire us, but not always towards the right thing. The symbol sometimes betrays the substance and moves us to actually destroy the ideal which was sought. How we solve this problem, I confess I do not know. One can only hope that the symbols without substance will eventually lose their power in this selective process and that the human race out of its bitter experience will move toward symbols which reflect rather than distort the substance of human betterment.

The history of the moral economy does seem to exhibit a learning process. Thus there is agreement now that prohibition, which was the political expression of a widespread grass roots movement in the moral economy in the United States, was a mistake. It represented a misapplication of moral resources, even though it did diminish cirrhosis of the liver. It can be seen as a classic example where the hatred of the very real evil of alcoholism, with an inadequate image of the love of good, probably made the problem worse.

Genetics and Discrimination

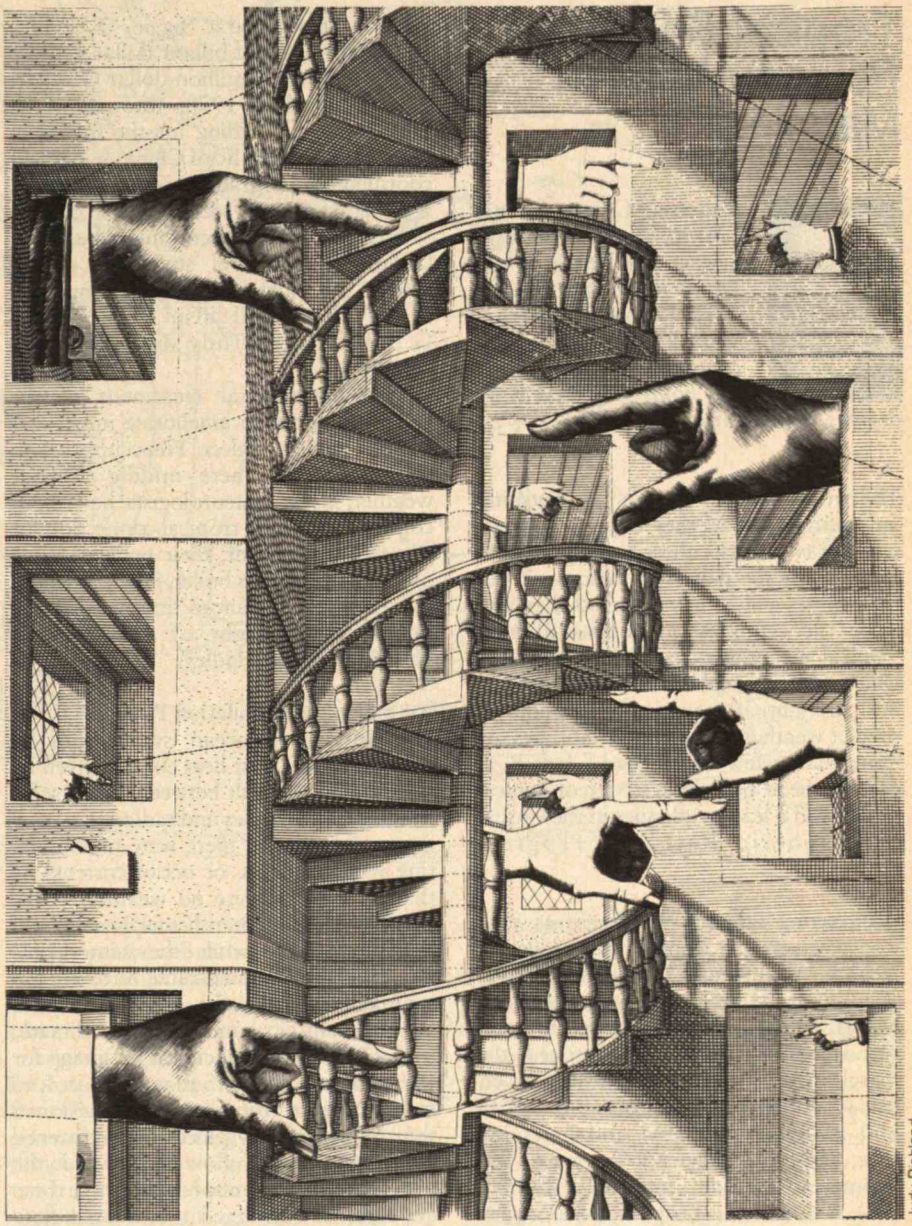
Perhaps the greatest expression of the moral economy in the last generation is in the movement against discrimination: racism, sexism, and more recently agism. These have been more sophisticated and successful than the earlier temperance movement.

In regard to race, we are still a long way from a fully integrated society, but these can be no doubt that the direction of change in the last 40 years has produced much good. The Bakke decision certainly suggests that the problem of who pays compensation for past and present discrimination has not yet been solved. Justice is a Holy Grail; we must always pursue it, but as we get closer to it, it also constantly eludes us. The legal prohibition of racial discrimination rests on a very firm foundation, in that the genetic differences within the races are much larger than they are between them. Race is, therefore, a very poor criterion by which to judge the potentials of an individual. The prohibitionist approach, therefore, which seeks to define and prohibit instances of racial discrimination, in this case has a high chance of success. Here the moral economy seems to be very efficient.

The problem of sexual discrimination and equality of status as between women and men is more subtle and may not respond so easily to a simple prohibitionist approach. The genetic differences between the sexes are much larger than the genetic differences between the races and this has been reflected historically in differentiation of function, which has led to a lower status for women, occupational discrimination by sex, and also a serious waste of human resources. While the

status of women has risen and fallen in various times and places throughout human history, it has hardly ever risen to what we would regard today as satisfactory. In the modern world, the human race has embarked on an almost unprecedented enterprise of creating societies in which sex is no longer a source of discrimination, injustice, and waste. This is, however, a complex and difficult task which involves substantial cultural change as well as modification of the legal structures which will support this change.

It would be unfortunate if the energies of the moral economy were diverted in this regard to symbols rather than to substance. In this regard the Equal Rights Amendment poses a particularly agonizing dilemma. As a symbol it is of great importance, so that a failure to pass it will almost certainly damage the cause of equal status of the sexes. Nevertheless, its passage might not advance that cause, simply because when there are real differences, the language of equality can be used to generate inequality. The great danger would be if the symbol were mistaken for the substance and if the passage of the Equal Rights Amendment resulted in a relaxation of the constant detailed efforts necessary to develop a culture of equality. If I were a state legislator I would certainly vote for the E.R.A. as a symbol. I would, however, have considerable qualms as to whether this was really going to further the objectives which it has in view.



Judy Richland

Overseeing Life Patterns

Eliminating discrimination on the basis of age becomes even more difficult. The abolition of an arbitrary age of mandatory retirement is only one step towards solving a problem of great complexity. Trying to do justice to and to utilize the resources of one age group could have the effect of adversely affecting the fortunes of others. Individuals age at very different rates, due partly no doubt to their genetic inheritance but also to their culture and lifestyles. Uniform vesting of rights in particular jobs, therefore, especially under the convention that income continues to rise with age, can easily produce both injustice and a waste of resources, as older people continue to occupy, often with enhanced wages and salaries, positions which younger people could do better and cheaper.

The organization of whole life patterns almost defies control, particularly as age segregation within our educational system has produced youth cultures and indeed age cultures which could potentially be quite catastrophic. In modern society many more people live to be old; with the conquest of diseases of youth, the problem of the total life pattern becomes more acute. The legislative aspects extend not only to mandatory retirement, but also to pensions, social security, saving, whole life income patterns, and so on. This prescience of many decades is hard for both voters and legislators to envisage. Equal rights for individuals over their whole lifetime may well involve quite unequal rights at different ages. One would hate to have to write a constitutional amendment to take care of that problem.

Discrimination is by no means the only, and perhaps not the most important aspect of the moral economy today. Questions of war and peace, of income redistribution, of energy, of the antinuclear movement, of environmentalism, all demand careful moral analysis. All of them are at least as thorny as the discrimination problem. Their discussion, however, will have to wait for another time. □

Tropical Boiler Powers Weather Machine

Robert C. Cowen, Science Editor of the Christian Science Monitor, *is former President of the National Association of Science Writers and is a regular contributor to the* Review. *He holds S.B. and S.M. degrees in meteorology from M.I.T.*

The world's meteorologists are pursuing an ambitious goal: they hope to forecast weather two weeks ahead as accurately as they do for the day after tomorrow. But their hopes will be in vain unless they also solve the centuries-old enigma of how tropical heat powers the weather machine. Unless the atmosphere's boiler "is taken into account, it may not be possible to predict weather in the middle latitudes for more than a few days ahead," says B. J. Mason, head of Britain's Meteorological Office and a leading planner in the Global Atmospheric Research Program (G.A.R.P.).

Deciphering Tropical Weather

Consequently the tropics have become a focus for the most elaborate international scientific field operations ever undertaken. BOMEX (Barbados Oceanographic and Atmospheric Experiment) initiated the search in 1969. Canadian and U.S. scientists scrutinized a rectangular box 500 by 500 kilometers in area and extending from 500 meters beneath the sea to five kilometers altitude. In 1974 G.A.T.E. (G.A.R.P. Atlantic Tropical Experiment), a 100-day data-gathering operation, concentrated on the tropical Atlantic between Africa and South America. Dr. Mason, who chaired G.A.T.E.'s governing board, called it "probably the largest, most complex international scientific experiment ever undertaken." Some 5,000 scientists and technicians from 72 nations supported by a thousand land stations plus 39 ships, 13 aircraft, and several satellites observed over 50 million square kilometers. Meteorologists believe that these tropical observations will provide the key to more realistic computer models of the atmosphere, and unlock the causes of short-term climatic change.

Now G.A.R.P. nations have launched the First G.A.R.P. Global Weather Experiment — they called it "figgie" (F.G.G.E.) for short — a half-billion dollar venture that dwarfs the 8-million-dollar G.A.R.P. From December, 1978, through 1979, 144 nations (including for the first time the People's Republic of China) will join a coordinated program to observe global weather in detail, accenting the tropics. Where G.A.T.E. concentrated on the Atlantic, F.G.G.E. will study the tropics around the Earth using satellites and aircraft. There will also be a special G.A.T.E.-like study of the Asian monsoon.

This preferential treatment of the tropics is partly to ameliorate many decades of benign neglect. Preoccupied with northern hemisphere middle latitude weather, most meteorologists have been content to take the tropical connection for granted. As a result, their understanding of the atmosphere's boiler, in a fundamental sense, has advanced little beyond the imaginative insight of 18th-century physicist George Hadley.

An Image for Circulation Patterns

The atmosphere-ocean system can be thought of as a vast heat engine driven by the thermal gradient between excess solar heating in the tropics and radiational cooling at the poles. If there were no circulating winds, storms, or ocean currents — that is, if there were no weather — the tropics in the winter hemisphere would heat unbearably while the winter pole would cool to near absolute zero. It's the weather machine that spreads tropical heat to maintain a more equable climate.

In 1735, Hadley sketched an image for the tropical boiler that still colors meteorological thought. He envisioned the trade winds, warmed and moistened by tropical seas, flowing toward the equator in both hemispheres. Where these air currents converged they would flow upward to generate deep convective cloud systems with attendant rain. In this way, tropical energy would be carried aloft where high altitude winds propel it northward and southward.

This oversimplifies the flow of tropical energy. Swirling horizontal eddies, such as the mid-latitude storms, transport much of the energy and momentum. Nevertheless, meteorologists still consider the "Hadley circulation" to be valid as a statistical average and a handy image for thinking about the tropics' role in planetary weather. They have located this pattern in the Intertropical Convergence Zone, a region a few degrees from the equator where trade wind currents do seem to converge and flow upward in outbreaks of convection. This is corroborated by satellite pictures by lines of convective clouds running more or less parallel to the equator.

However, trouble arises when meteorologists examine tropical circulation in detail. How "real world" systems interact to produce the tidy Hadley circulation even as a statistical average remains unknown to the researchers who gathered at an international conference on tropical meteorology last August. They met in London under sponsorship of The Royal Society and of the American, British, and German meteorological societies.

Flies in the Ointment

Typhoons and hurricanes portend a more complicated model. Individually, and in their season, these violent storms pump large amounts of energy into the general planetary air circulation. Yet it is hard to see how they fit into the tropical boiler's operation.

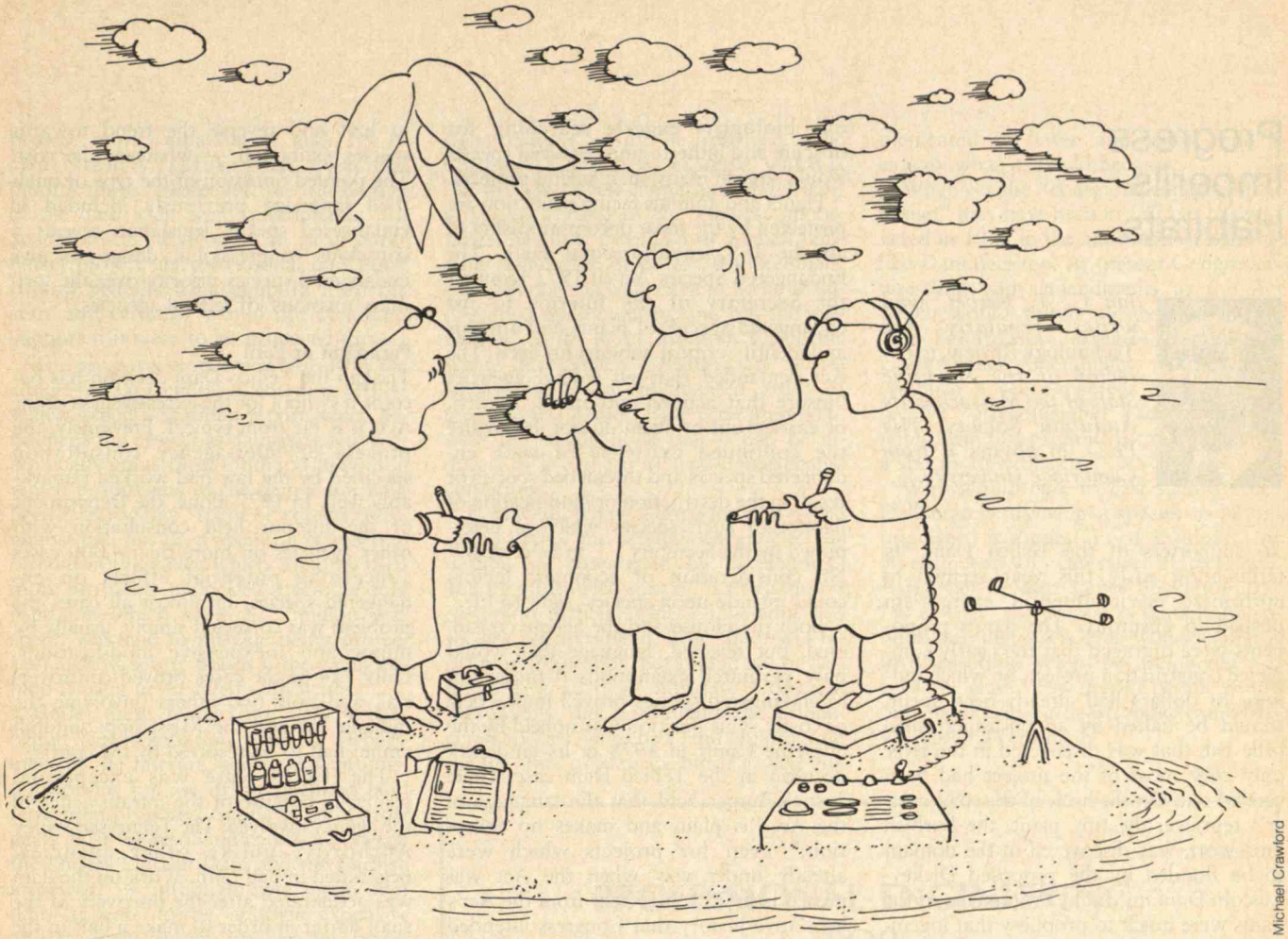
Taking one point of view, Herbert Riehl of the National Center for Atmospheric Research, the doyen of tropical meteorology, observed that a dozen or so large hurricanes spread around the equator would take care of heat transfer in the tropics without the need for the Intertropical Convergence Zone. "It is a very realistic question," he said, to ask why there isn't such a hurricane-dominated circulation. "If we saw it there, everyone would say that was very natural," he added.

On the other hand, William M. Gray of Colorado State University believes that hurricanes have a minimal effect. On a yearly average, their energy contribution to the atmosphere's general circulation is only about 2 per cent. Indulging in a bit of hyperbole, he added, "If we did not know that tropical cyclones occurred, it is doubtful that, with our current understanding of fluid mechanics . . . we would have believed their existence possible."

Why then do hurricanes occur? Why do some of the tropical disturbances intensify to generate about 80 cyclonic storms a year, of which half to two-thirds reach hurricane strength? Dr. Gray considers this one of the key mysteries in tropical meteorology.

Cyclones Serve Seasonal Need

Undoubtedly tropical cyclones are a distinctive characteristic of the present atmospheric circulation. Year after year they occur in preferred locations and with a seasonal bias. Predominating in regions of the eastern Atlantic, the eastern and western Pacific, and the Indian Ocean,



Michael Crawford

about two-thirds favor the eastern as opposed to the western hemisphere. Most relish late summer and autumn, when rain over land is relatively sparse. Noting this, Dr. Gray remarked that during this season "more of the global rainfall must come from organized weather systems such as the tropical cyclones. It is interesting that tropical cyclone activity is maximum at this time."

Over three times as many cyclones erupt in August and September as in April and May, according to Dr. Gray. In this fall period, "they likely account for about 4 to 5 per cent of the global precipitation while during April and May only about 0.5 to 1 per cent. During the fall tropical cyclones also inject a wealth of kinetic energy into the northern hemisphere winds. 10 to 15 per cent of that wind energy is generated between August and October and as much as 20 to 30 per cent when the cyclones are particularly active. This massive energy contribution comes just when northern circulation is building up to winter strength. It's as though the cyclones were part of a system by which the atmosphere can tap the tropical energy and moisture store when it has a special seasonal need. This certainly suggests that the storms have an important role in world weather. But how to account for that role when meteorologists can't explain why the cyclones arise in the first place?

Equally mysterious to meteorologists is how the organized cloud systems that trace the Intertropical Convergence Zone so neatly export energy out of the tropics if indeed they do so directly at all. The interaction between such systems, larger disturbances, and the general tropical air circulation seems to have become more obscure the more closely it has been studied.

All told, there are enough uncertainties for some of the scientists at the London conference to suggest scrapping Hadley's simple scheme altogether and looking for a new basic concept. But Yale Mintz of Goddard Space Flight Center insisted on its underlying validity. Proposing that the air may move in narrow streams instead of rising and fanning out in broad sheets from the Intertropical Convergence Zone, he showed satellite photos that do reveal such well defined narrow air flows carrying water vapor.

But no one questioned that the tropics are a key factor in global weather which, once interpreted, will improve weather forecasting. J. S. Winston of the U.S. National Oceanic and Atmospheric Administration finds evidence in the last two unusually severe northern hemisphere winters. Large increases in general circulation wind energy were accompanied by intensified potential energy in the tropics manifested by patterns of cloudiness, which influence radiational heating and cooling. Distinctive tropical circulation patterns also arose.

Despite many correlations, the tropical enigma will not be swiftly cleared away by the massive data-gathering programs such as G.A.T.E. and F.G.G.E. The scientific work takes many times longer than the field studies, and refined data from G.A.T.E. are only now becoming widely available. F.G.G.E. is planned to extend through at least 1986 to allow for data preparation and analysis. Meanwhile, some meteorologists warn that assembling more data is no royal road to knowledge, however much they may welcome the observations. There's enough data already in hand to solve the mysteries of the tropics, says Herbert Riehl: "It is essentially a question of thinking and analysis to solve the principal questions." □

Progress Imperils Habitats

Ian C. T. Nisbet, who writes regularly for Technology Review, *is Director of the Scientific Staff of the Massachusetts Audubon Society. His Ph.D. in physics is from Cambridge University.*

To supporters of the Tellico Dam, its termination early this year seemed to epitomize environmental extremism pushed to absurdity. The dam's proponents were outraged that the nearly completed construction project, on which millions of dollars had already been spent, should be halted by an undistinguished little fish that was discovered in the river only *after* most of the project had been carried out. On the heels of the snail darter's reprieve, the tiny plant, the Furbish lousewort, was discovered in the domain to be flooded by the proposed Dickey-Lincoln Dam in Maine. Proponents of the dams were quick to prophesy that ingenious biologists eagerly searching for obscure and hitherto unrecognized species would squash many such federal projects.

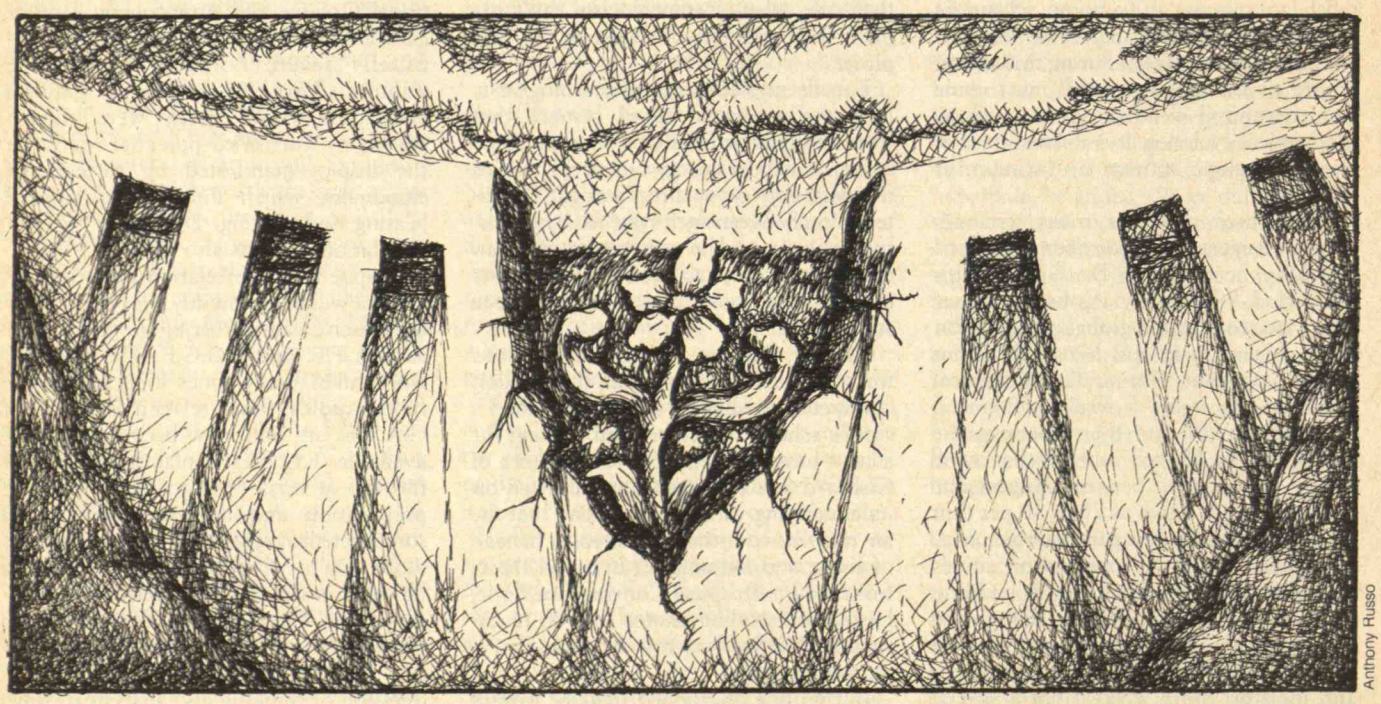
Plants and animals facing extinction are protected by the most uncompromising of all the U.S. environmental laws. The Endangered Species Act of 1973 required the Secretary of the Interior to list endangered species of plants and animals and identify critical habitats for each. The Act demanded that all federal agencies "insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary . . . to be critical." No consideration of economic factors could intrude upon species' right to life.

Both the House and the Senate considered, but rejected, language that would have permitted exemptions if protection of endangered species proved impractical or costly. This position was upheld by the Supreme Court in 1978 in its landmark decision in the Tellico Dam case. Chief Justice Burger held that the language of the Act "is plain and makes no exception," even for projects which were already under way when the Act was passed in 1973. "It is clear from the Act's legislative history that Congress intended to halt and reverse the trend towards species extinction — whatever the cost. The pointed omission of the type of qualified language previously included in endangered species legislation reveals a conscious congressional design to give endangered species priority over the 'primary missions' of federal agencies."

Paradigm or Peril

Though the Tellico Dam decision has become a symbol for the excessiveness of the Act, it is far from typical. Previously, the process of inter-agency consultation specified by the law had worked remarkably well. In 1977 alone, the Department of the Interior held consultation with other agencies on more than 4,000 cases concerning potential effects on endangered species. In almost all cases the problem was corrected simply, usually by minor and inexpensive modifications. Only 124 of the cases proved controversial, and only two others (involving the Indiana bat and the Mississippi sandhill crane) had to be resolved by the courts.

The Tellico case was exceptional primarily because of the intransigence of the agency involved. The Tennessee Valley Authority, unlike other agencies, negotiated in bad faith. Work on the dam was accelerated after the discovery of the snail darter in order to make a halt in the



Anthony Russo

project more unpalatable, and T.V.A. consistently refused to consider modifications. Moreover, the advantages of the dam itself were questionable. An anachronistic survivor of an early pork-barrel project, its recreational and flood control benefits were doubtful from the start and certainly would not command support if it were to be proposed today.

The controversy spawned a study by the congressional General Accounting Office, which issued a scathing report which denounced the project as damaging and economically unjustified. Of the $120 million which proponents of the dam claim have been "irrevocably" spent on construction, almost half has been spent on acquisition of land in the valley which could be used more profitably unflooded. Even the dam itself, on which some $22 million was spent, was said to provide better protection against severe floods if the valley behind it were never filled with water.

Under new leadership, T.V.A. has begun real negotiation with the Department of the Interior, and several promising options for use of the acquired land have been proposed. Similarly good prospects exist for resolving conflicts between the Dickey-Lincoln Dam and the Furbish lousewort — although here again that dam appears to be another expensive anachronism which would be better abandoned before any more money is wasted on it.

Nevertheless, the overall ease with which disputes over endangered species have been resolved may have drawn environmentalists into complacency. The lack of controversy can be attributed to the timid progress of the Department of the Interior in implementing the Act. After five years of work, only 192 species have been given "endangered" status (33 mammals, 67 birds, 45 reptiles, amphibians and fishes, 32 invertebrates and 15 plants). Action is still pending on 141 species of animals and 1,850 species of plants which have been proposed for protection. Most troublesome is that critical habitats have only been designated for 29 species. At this rate several centuries will have elapsed before even the barest procedures for protecting endangered species are completed.

Softening an Absolute

Although most of the endangered species identified live in remote and often restricted areas, the potential for conflicts is bound to increase as the number of designated species and critical habitats enlarges. Already it is clear that some conflicts cannot easily be resolved. The California Condor, for example, which is the world's largest flying bird and a conservation symbol of the greatest importance, has now dwindled to a small remnant population of 20 to 30 individuals. The Condor can only exist in areas of undisturbed open country, and has the misfortune to do so in southern California where development pressures are almost irresistible. Small, fragmented areas of their natural habitat have been preserved, with the fragile hope that it can be induced to live there in semi-domesticated conditions.

In Hawaii, where a large fraction of the native plants and animals endemic to the islands are threatened by development and by introduced species, the situation is even more difficult. Once all the imperiled species are accounted, little space will remain on the islands that should not be designated a critical habitat. Congress presumably did not intend the Endangered Species Act to be a land use program for the state of Hawaii, but if it were implemented in letter and spirit that is exactly what it would become.

Whatever the "conscious congressional design" may have been in 1973, it has wavered in 1978 in the aftermath of the Tellico Dam decision. At present Congress is wrestling with amendments to the Act which would soften its absolute intent. The Senate has already passed the Culver-Baker Amendment, which would establish a seven-member committee to resolve "irreconcilable" conflicts. Five votes from this committee could condemn a species to extinction.

Who would care to cast such a vote? Deliberately allowing a species to be extinguished is a question of absolutes, for an extinct species can never be recreated. As former Senator James Buckley put it, "In essence, the process is tantamount to book burning, yet is even worse in that it involves books yet to be deciphered and yet to be read." Few literate people would burn books, but at least books can be rewritten and reprinted. □

The corporation and human values•Science vs. the liberal arts•Continuing to grow

Some of the most fundamental problems of business today are those having to do with human relations and human values, and this seems likely to continue for years to come.

We have crossed the threshold of an era of scientific and technological development that has already altered the world we live in more sharply than at any time in history, and is continuing to alter it. It seems to us imperative that mankind's burgeoning knowledge be based on sound moral and ethical values.

We must continue to raise the standard of living in a world whose population is growing prodigiously even after some slowdown in recent years and, through this improved living standard, preserve and enlarge the freedom of the individual.

Whether or not mankind achieves the potential made possible by advanced technology, and to what degree, will depend in large part on the availability of sufficient economic freedom to provide scope for human resourcefulness; a broadly educated populace; and the confidence and the will to keep pushing ahead.

Mobil is deeply involved in all of these spheres. Perhaps our first and most basic requirement is for people—for an adequate and continuing reservoir of the essential skills without which a company in our business cannot succeed.

What sort of people make up our company, and what do we try to do with them and for them?

Their skills range from accounting through secretarial to zoology. In our recruiting, once we establish the technical or scientific qualifications of an engineer or a chemist, for instance, we look for about the same qualities in both the scientifically trained and the liberal arts students. We have learned that a business hires the whole person, and that in the long term motivation and character traits are more important than specific skills and knowledge.

Our business is so complex, even in its nontechnical aspects, that no one person can master all of it; so, to do one's job, one has to be able to work effectively with others. In a person's supervisory work, one of his or her prime functions must be the development and perceptive coaching of subordinates, since today they must accomplish most of the work and tomorrow one of them may have to replace him or her. Thus individuals with broad experience, the ability to think clearly and productively, and a determination to improve the status quo can make substantial contributions to the corporate effort.

The job of management is in the most fundamental sense the job of encouraging and helping people to develop themselves—keeping in mind that it is always some *one* person who is being trained, and that each person will differ from his or her peers in respect to specific needs and capabilities. Management must provide the sort of employment and work experience that will utilize the individual's abilities more effectively than those abilities could otherwise be used.

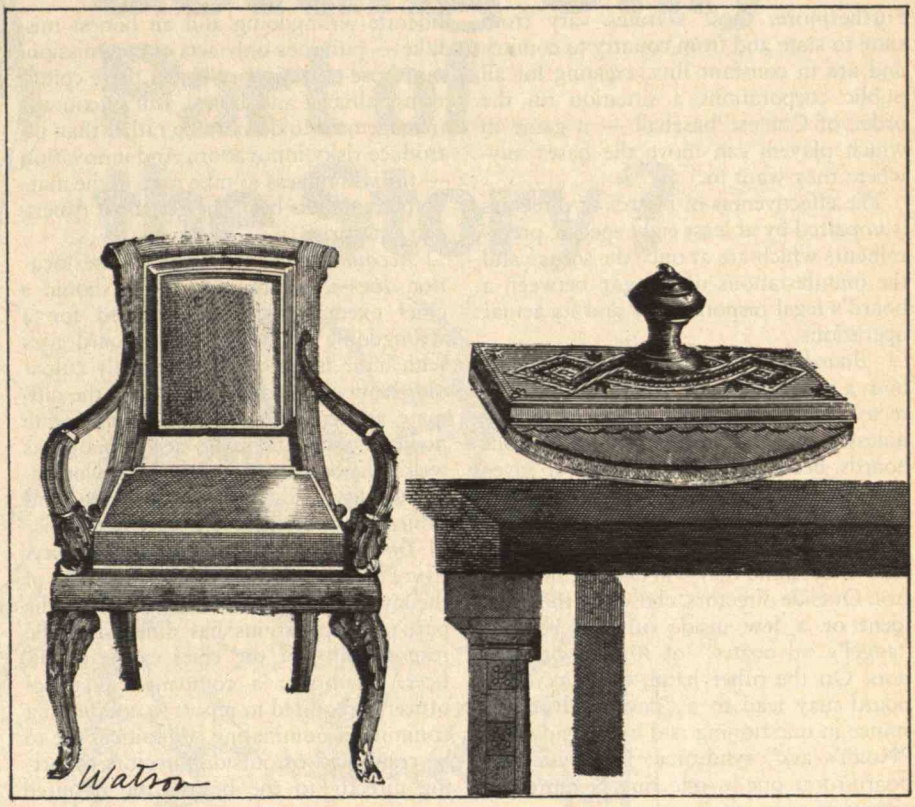
We have learned by experience that when we are looking for a man or woman with executive ability to promote—and our need for managers who can move up is endless—an individual's ability to deal with abstract problems involving judgment and the ability to reason is often more significant at that juncture than any technical knowledge.

We are in a technology-intensive industry and therefore will continue to need highly trained and skilled scientists and technicians. But science is concerned largely with the measurable, and when you have summed up all the factors of an individual that can be measured, you still have not described nor understood that person. What is critically important in the long term is the broader dimensions of knowledge and insight that enable people to deal successfully with a variety of social and economic problems.

We know that in our own case we require young people of moral stamina who can think and who can identify priorities. Given such individuals, along with the good sense of the American public once it has the facts, we believe that freedom can survive in our country and that a resourceful, well-managed business can prosper, benefiting from and contributing to the growth and development of the people who constitute it.

The Crisis of Corporate Boards

Warren G. Bennis has been watching people and their organizations ever since studying for his doctorate in psychology (1955) at M.I.T.'s Sloan School of Management. He's now living in Aspen, Colo., planning a new career after 20 years in academic administration at the State University of New York at Buffalo and the University of Cincinnati (President, 1971-77).



Karen Watson

But I'd shut my eyes in the sentry-box,
So I didn't see nothin' wrong.
— Rudyard Kipling

The now famous McCloy report, undertaken as a result of corporate actions ranging in their seriousness from "ethical insensitivity" to criminally liable behavior, concludes: "It is hard to escape the conclusion that a sort of 'shut-eye sentry' attitude prevailed upon the part of both the responsible corporate officials and the recipients as well as on the part of those charged with enforcement responsibilities."

What *is* the proper role of a board of directors in the conduct of corporate affairs?

A former Penn Central director admitted shortly after the fall of that corporation, "I don't think anybody was aware that it was that close to collapse." And Gulf's directors were clearly embarrassed by their company's illicit payments and other criminal actions.

The lesson from the Gulf and Penn Central situations is simple: unless directors have the right information and know how to ask the right questions, they tend to see only what they are told to look at; when something "wrong" happens they are apt to be jolted out of their lethargy by unfriendly lawyers rapping loudly on their sentry box.

The spectacular embarrassments of boards of directors in recent years have been warning flares lighting up the corporate skies. But fireworks unfortunately block from view the deeper, more difficult issues. At the same time, they may tend to act as tranquilizers, falsely lulling the sentry into confidence that the criminals have been purged and further liability curbed.

These unfortunate incidents have led to a stream of discussion, some of it shrill and not altogether rational. The business community, most of all, has been reexamining the composition, operations, and procedures of boards of directors. While there are indications that procedures and operations have been tightened, the increased public expectations about corporate performance are a long and nervous distance from realization.

It is still the case that most board members are, in fact, willing dupes of management. They are expensive, impotent, and often frustrated rubber stamps. They are subject to major litigation and are selected solely by their subordinates. They seldom understand their function, because of lack of proper orientation or education, and therefore they often meddle in management affairs. Old-timers who have learned the function of a board find that they have no way to assume those functions, given the history, tradition, or make-up of the particular board on which they serve.

An example of board confusion and the consequent resistence to change can be found in the case of Arthur Goldberg, a former member of the Supreme Court and Ambassador to the United Nations, who resigned as a director of T.W.A. on October 18, 1976, in a dispute over the directors' proper role. Goldberg attempted to establish an independent committee of outside directors to review the actions and recommendations of management. He argued that this group should be allowed to meet independently, without interference from "inside" directors, officials, or administrators, and should benefit from an independent staff of technical specialists. His proposal was turned down by the board, and Goldberg resigned.

In the two years since then, three dozen suits have been filed by disgruntled shareholders of the Penn Central Transportation Co. against the directors who had served that company prior to its receivership. These suits are based on a law imposing ultimate legal responsibility for the management of a corporate enterprise on boards of directors. More recently, the Securities and Exchange Commission has rebuked two outside directors of Sterling Homex Corp. for allegedly failing to obtain "a sufficiently firm grasp of the administrative, organization, and financial practices of the firm," accepting, according to the S.E.C. report, "superficial answers to questions put to management."

Players in a Chinese Baseball Game

The fundamental point here is that a gap in the corporate directors system exists between what state statutes say are the responsibilities of boards of directors and the realities of any board's operations.

Furthermore, these statutes vary from state to state and from country to country and are in constant flux, creating for all public corporations a situation on the order of Chinese baseball — a game in which players can move the bases anywhere they want to.

The effectiveness of boards of directors is impaired by at least eight specific predicaments which are at once the source and the manifestations of the gap between a board's legal responsibility and its actual operations.

☐ *Board Composition.* Though there is now a mix of "inside" and "outside" directors on most boards, charges of "clubbiness" still echo. Too often, people join boards because of the prestige it gives them or the stipend it pays, or because it provides an ideal activity for retired executives who want to keep busy but who understand they will exercise no control. Outside directors, chosen by the president or a few inside officers, become "angel's advocates" of top administration. On the other hand, diversity on a board may lead to a "devil's advocate" stance in questioning and often leads to a "Noah's ark" syndrome: filing into the board room one-by-one must be representatives of every type — one woman, one black, one Jew, one consumer — whose appointments are supposed to absolve everyone of guilt for years of neglect.

Knowledgeable, experienced women and minorities do have a place on boards, of course, but to pick them solely on the basis of prior neglect is an insult; and it is likely to lead to a board made up of people who know little about the enterprise and who raise so many single voices and write so many minority reports that conflicts cannot be resolved and progress is blocked.

The predicament, then, is how to create a board responsible to the shareholders without creating a political Noah's ark of dissident voices.

☐ *The Increasing Role of Law.* A board of directors cannot operate with a corporate management unless there is mutual trust and confidence. But today the law's increasing influence tends to erode this. Board members are now so vulnerable to and skittish about expensive lawsuits, for example, that they can no longer rely on the word of the chief executive officer in making decisions. They must have everything in writing, duly notarized, which often means that a corporation's legal counsel and chief financial officer play a more important role than the chief executive officer. Moreover, the law — which has difficulty distinguishing between deliberate wrongdoing and an honest mistake — punishes only acts of commission, not those of omission. Under these conditions, almost any board will encourage management to do nothing rather than introduce risky innovation. And innovation — the willingness to take risks in the marketplace — has been the genius of American enterprise.

☐ *Accountability.* At what precise location does the buck stop? Why should a chief executive officer be fired for a wrongdoing unless the entire board goes with him? Isn't the board equally culpable? How can board members be the ultimate arbiters, the pinnacle of corporate power, without being accountable as well? The demarcation lines of power, responsibility, and culpability are vague and subject to many different interpretations.

☐ *Diminished Executive Responsibility.* Every reform resulting from infractions of the law or from criminal behavior on the part of corporations has diminished the responsibility of the chief executive officer. Examples: a company's financial officer is required to report to an auditing committee; nominating committees are to be composed of outside directors reporting directly to the board; the required standing committees on corporate social responsibility are to report directly to the board, rather than through the chief executive officer. Requirements such as these have the effect of preventing the leader from leading.

☐ *The Double-Bind.* The chief executive officer's responsibility, on the one hand, is to maximize the return on the shareholders' investment. But the competitive practices by which this obligation is fulfilled — normally quite within the accepted norms of the enterprise — may now suddenly be made illegal by a law that is in flux. To the traditional conflict between risk-taking and corporate security there is thus now added subtle pressure of the chief executive officer to assure his personal immunity to legal action.

☐ *Conflict of Interest.* What is the position of a member of a bank board, for example, who serves also as financial adviser for an enterprise which is a customer of the bank, or of a lawyer on a university's board who represents a firm that does business with the university? Such relationships deserve careful scrutiny. But it is difficult to find knowledgeable, sophisticated candidates for boards of directors who have no ties whatever to other institutions. Indeed, if all board members with multiple obligations were forced to resign, we would end up bringing people with no knowledge, sophistication, or advisory capacity into positions of power.

☐ *The Ambiguity of State Statutes.* There is no uniformity in the state statutes under which corporations are chartered, and many are highly ambiguous. For example, no state statute distinguishes between outside and inside directors. This general ambiguity frustrates attempts to define precise roles for directors, and as a result it is virtually impossible to answer the question, "Who's in charge?"

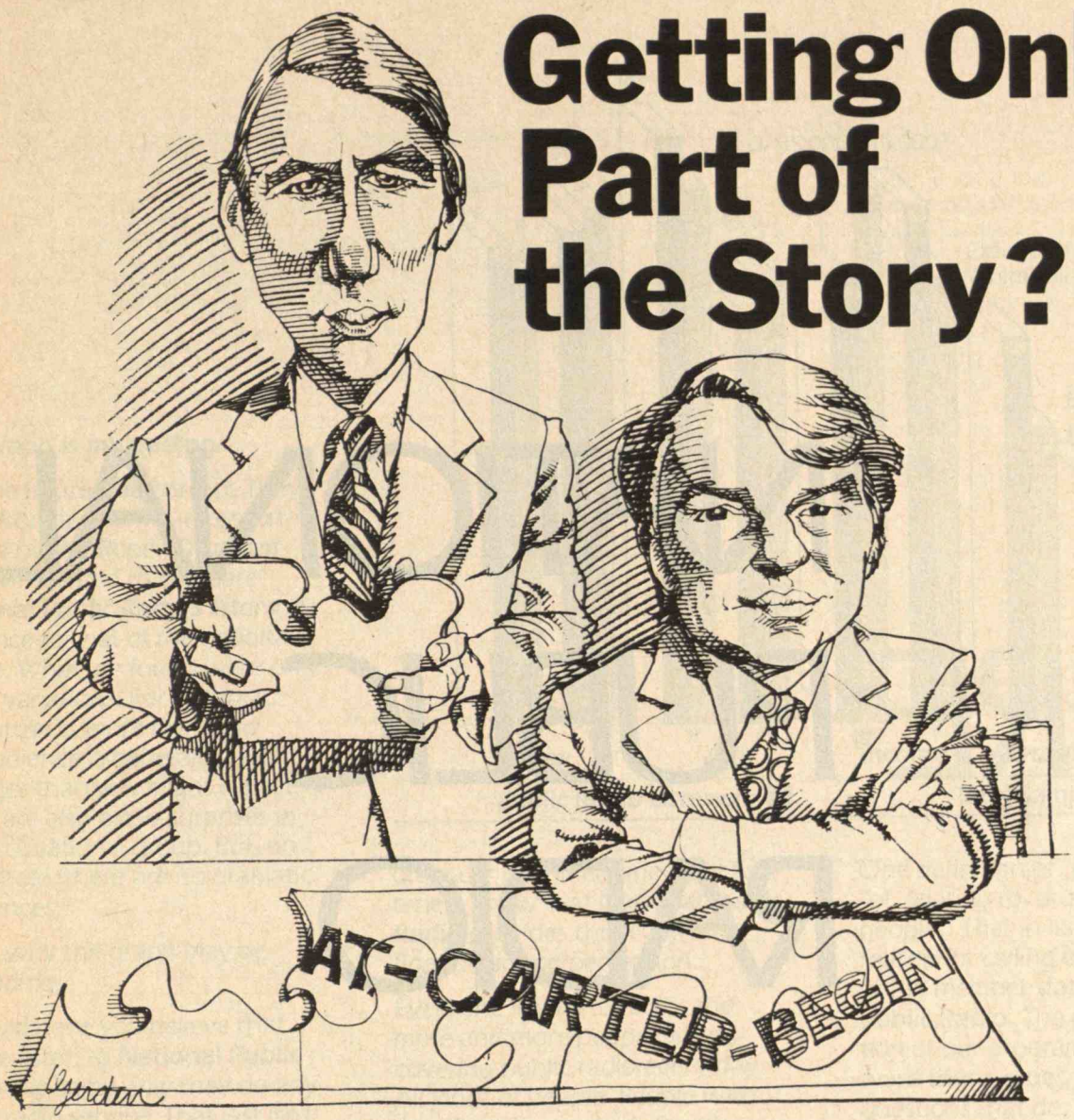
☐ *The Education of Board Members.* It is not possible for board members to ask discerning questions, to understand their full legal and managerial prerogatives and responsibilities, or to fulfill their responsibilities without orientation and education; but most begin their terms completely naive about their roles. There is little or no orientation. New board members usually receive at best a glossy confection supposed to provide a description of the institution, but which in reality offers little more than the typical annual report. Given the many competing pressures for their time and attention, how can board members learn what they need to know about the enterprise they serve and the environment in which it operates?

Confusion Rampant

There was a time when directors rarely had to dirty their hands or minds with anything but vague fiduciary responsibilities or the occasional selection of a president; today they find themselves surrounded by shrieking shareholders, lawsuits, and illicit practices, and they're confused. The major problem is the gap, more and more obvious, between their governing role as decreed by law and the reality of our complex, rapidly changing contemporary scene. ☐

Next month Dr. Bennis will offer some recommendations for increasing the effectiveness and decreasing the frustrations of boards of directors.

Tired of Getting Only Part of the Story?



The MacNeil/Lehrer Report Puts All the Pieces Together.

Robert MacNeil and Jim Lehrer do what other TV news reporters say they'd like to do—devote each program to one story...the *whole story*.

Since October, 1975, the MacNeil/Lehrer Report has examined more than 500 topics in-depth...full, balanced and timely discussions on important public issues.

So, if you're tired of getting bits and pieces of a story, tune in to MacNeil/Lehrer, the only nightly news program to win broadcasting's TRIPLE CROWN in 1978—the Emmy, Peabody and DuPont/Columbia Awards.

It's like no other news program.

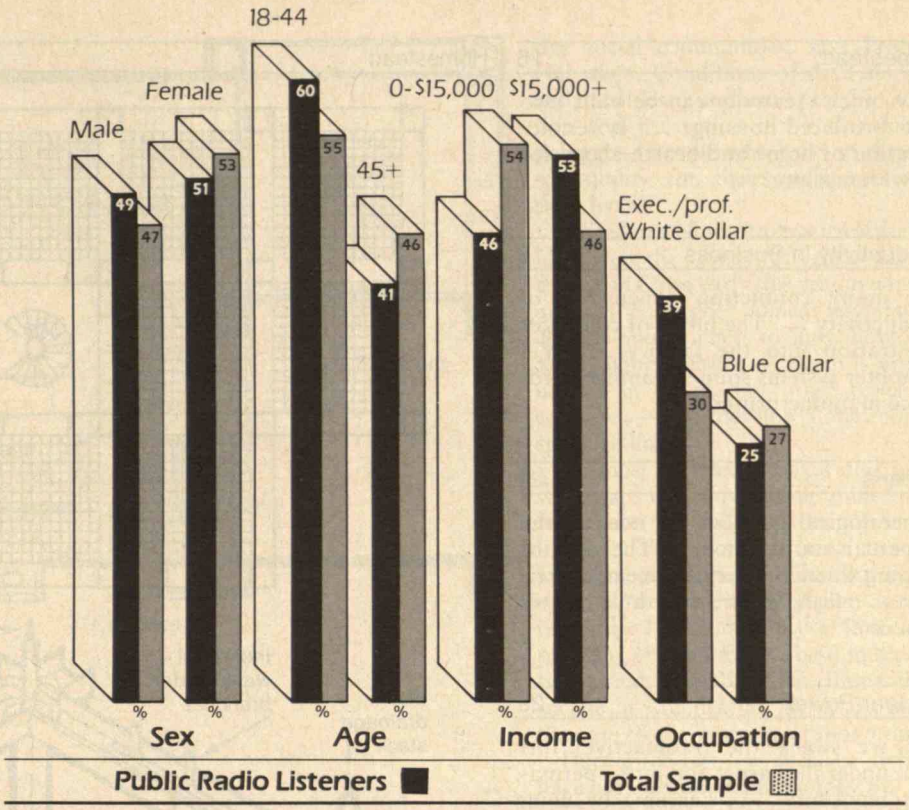
The MacNeil/Lehrer Report is co-produced by WNET/New York and WETA/Washington, D.C. and made possible by grants from Allied Chemical Corporation, Exxon Corporation, the Corporation for Public Broadcasting and member stations of PBS.

The MacNeil/Lehrer Report
With Correspondent Charlayne Hunter-Gault

WEEK NIGHTS ON PUBLIC TELEVISION STATIONS
CHECK YOUR LOCAL LISTINGS

Allied Chemical

NATIONAL RE:PUBLIC RADIO



This graph is misleading.

Oh, the figures are correct. They come from a recent survey conducted by the Roper Organization. We wanted to compare **National Public Radio's** listening audience to that of the national profile. What we found were only minor variations. For instance, **NPR** attracts more men, and our audience is generally much younger than you might expect. There are also a few surprises in the occupational group. But, on the whole, there are no dramatic differences.

That's why the graph may be misleading.

It would have you believe that people listen to **National Public Radio** the same way they do any other radio service. That just isn't true. **NPR** listeners do not think of us as just background sound. They have switched to **NPR** because their tastes are as diverse as our programming.

What the chart on this page does **not** show you is that some of these statistics represent jazz buffs, as well as opera fans, folk festival advocates, and a lot of people who rate our brand of news and public affairs are among the best information sources in the country. But whether it's opera or news, drama or documentaries, our listeners know that **National Public Radio** provides them with the finest in sound perception.

Everyone listens to radio, and more and more people are discovering public radio every day. All kinds of people. People with one thing in common. People who have found that **National Public Radio** programs support their concern and involvement with all aspects of their local and national communities. They have discovered that public radio is the personal, portable, immediate medium suited to today's lifestyle, and that **NPR** designs programming to respond to their individual needs.

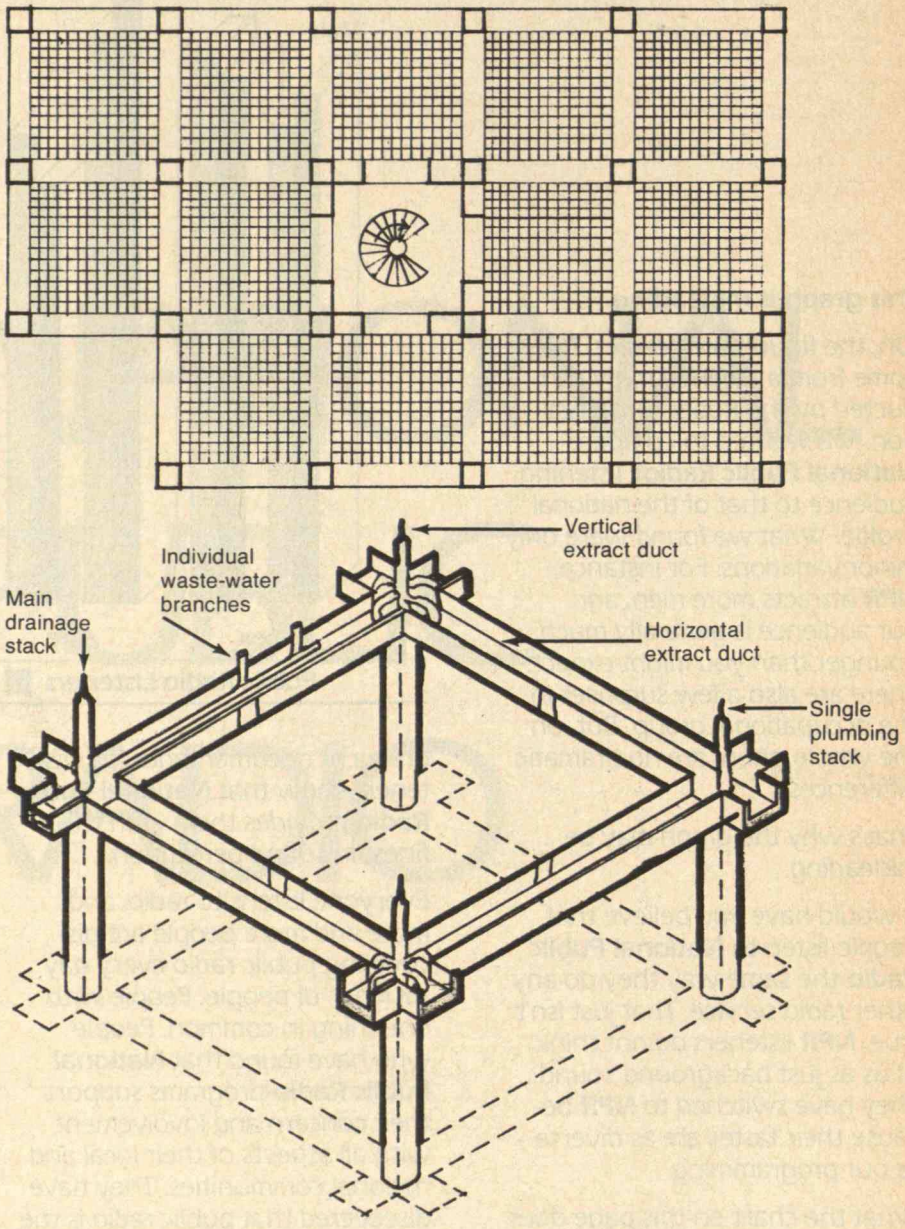
One definition of "public" is, "of, relating to, or affecting all the people." That in itself is a good reason for calling our network of 215 member stations **National Public Radio.** The principal direction of our programming is toward those issues, people, and questions that do, indeed, affect all Americans.

Our programs make us unique. That's the way our audience likes it. We intend to keep it that way.

After all, our middle name **is** "public."

If you'd like more information about National Public Radio, our programs and plans for the future, write to
NPR
Dept. L
2025 M St., NW
Washington, DC 20036.

Trend of Affairs

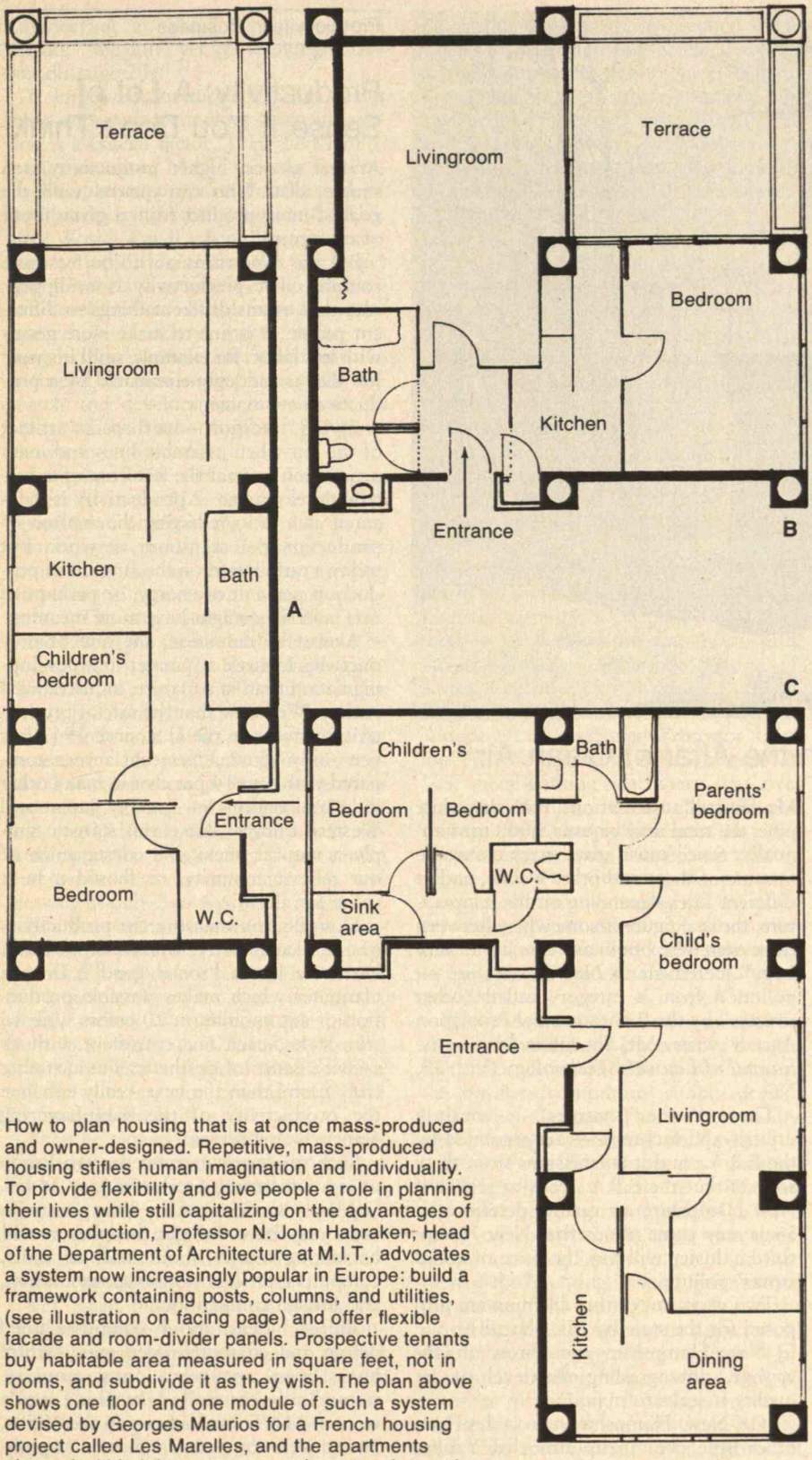


Can Mass-Produced Housing be Yours Alone?

Let five families buy and move into five identical, mass-produced houses in the same neighborhood. Two years later the five houses will no longer be identical. Their colors will be changed, their furnishings different; they may even have added new rooms and new floor plans.

The sameness of the new houses was the result of unimaginative commitments to mass production by centralized decision-makers, says Professor N. John Habraken, Head of the M.I.T. Department of Architecture. The variety observed two years later is the hallmark of the individual initiative which is the instinctive compulsion of every human.

Most public housing the world over has been produced by paternalistic public commissions for tenants who were assumed to be incapable of making decisions about their own housing. It's now clear that such projects have suppressed their residents' sense of initiative and failed in the goal of creating stable, effec-



How to plan housing that is at once mass-produced and owner-designed. Repetitive, mass-produced housing stifles human imagination and individuality. To provide flexibility and give people a role in planning their lives while still capitalizing on the advantages of mass production, Professor N. John Habraken, Head of the Department of Architecture at M.I.T., advocates a system now increasingly popular in Europe: build a framework containing posts, columns, and utilities, (see illustration on facing page) and offer flexible facade and room-divider panels. Prospective tenants buy habitable area measured in square feet, not in rooms, and subdivide it as they wish. The plan above shows one floor and one module of such a system devised by Georges Maurios for a French housing project called Les Marelles, and the apartments planned within it by a young couple — teacher and student (**B**), a couple with three young children (**C**), and couple with teen-aged children (**A**).

tive social communities, says Professor Habraken. Conditions of drab sameness and "soul-less" uniformity tend to alienation and frustration in "a new kind of poverty — people who have no direct responsibility for their environment and their lives."

It need not be so. Professor Habraken's ideas were the keynote of a three-day conference in Cairo early this year in which he and his colleagues joined Egyptian architects and planners to show how large-scale public housing — which is urgently needed in Egypt and other developing countries — can develop along more responsive lines.

To most architects, boxes and panels, which are the conventional units of prefabrication for buildings, seem inherently limiting. Furthermore, most designers self-righteously assume that all they need to do is "design the 'ideal' plan and multiply it by 100, 200, or 1,000 to solve the problem of dwelling." These misconceptions, said Eric Dluhosch, Research Associate in Architecture at M.I.T., are "at the core of the problem of monotony."

During the last few decades, architects have tried to conquer monotony by "playing" with external form, using zig-zags, decorations, and "playful," cosmetic devices. Professor Habraken suggests a more radical approach to achieve responsive design in mass housing, using a structural system which provides only the basic support structure and utilities for housing units, laid out on the basis of community decisions. Would-be owners are offered an area of habitable space to be utilized as they wish, rather than a group of rooms. This "infill" may be built or bought in prefabricated units, and architects' help is available as required. Such a system assures the occupants' commitment to their apartment with essentially no cost penalty.

Can such opportunities for independence be carried too far? Perhaps, Dr. Dluhosch admitted. Some decisions clearly need to be made by the community, to protect community interest and Dr. Dluhosch and his colleagues at M.I.T. are now seeking the proper balance. "In cases where you have an overwhelming expression of individuality," he admits, "you tend to have a lack of communal coherence." But at the other extreme, as Professor Habraken pointed out, the individual becomes submerged and lost in anonymity. The problem is to understand and give expression to the "difference between house and dwelling, where 'house' is a product and 'dwelling' is an act," says Dr. Dluhosch. — *J.M.* □

The apparent David-and-Goliath relationship of this New Hampshire air-monitoring shack to the factory is misleading. The real David may turn out to be the ordinary New Hampshire citizen who uses a wood stove for warmth. It is possible that such stoves may come to be considered a source of air pollution that threatens the air quality rating of the state, as determined by the U.S. Environmental Protection Agency. Should this rating degrade to the point where new, polluting factories were prohibited under the terms of the Clean Air Act, operators of wood stoves might come under pressure to extinguish their home fires.

Sacrificing Wood Stoves on the Altar of Clean Air?

Just over half of all households in New Hampshire burn wood for heat, and as oil and gas prices advance the number is rising: 5,600 wood-burning stoves were sold in the state in the fall of 1977. Will this proliferation of unregulated wood stoves so degrade New Hampshire's air quality that new industries, which would be regulated polluters, are foreclosed from the state?

The clash seems "inevitable," says Joseph Shortill, an environmental lawyer who won his J.D. earlier this year from the Franklin Pierce Law Center in Concord, N.H.

Few people think of wood as a serious pollution source. Its sulfur content is low, and only minimal amounts of nitrogen oxides are produced by even the hottest (2,500° F) wood fire. Whether photochemical oxidants released from wood fires can cause smog by reacting with other air pollutants is not known. The mischief is caused by what most of us like best about a wood fire — its smoke and its smell (read, in air pollution language, its particulates, gases, and tars).

New Hampshiremen may burn as much as 300,000 tons of wood a year. If it's all very dry red oak, this may put 1,000 tons of particulates into the air, according to Mr. Shortill's calculations. If it's dry white pine, the total may be over 5,000 tons annually. Since most stove-users use some mixture of these and other woods, and at different rates depending on the temperature, the real figure is somewhere between these extremes: but in any case it's a "very large" increment to New Hampshire air pollution from a category called "other sources" by the Environmental Protection Agency, writes Mr. Shortill in *Idea — the Journal of Law and Technology* (Vol. 19, No. 4).

These "other sources" — mainly utilities and factories — are regulated by the E.P.A.; and it is emissions from these sources that the E.P.A. seeks to reduce if New Hampshire air quality deteriorates. So it may come about that New Hampshire industry will pay the price of wood stoves' pollution.

Two ways out of this dilemma are proposed for the state by Mr. Shortill:

☐ New Hampshire can throw in the sponge, downgrading the level of air quality it seeks to maintain.

☐ Or New Hampshire can accept another little dent in its armor of Yankee individuality by establishing a permit system to limit the number of wood stoves.

— *J.M.* ☐

Productivity in Business

Productivity: A Lot of Sense If You Don't Think

At first glance, higher productivity is a simple idea. Who can quarrel with the goal of more product from a given input of resources?

But the issue turns out to be far more complex. For productivity is a slippery idea that means different things to different people: it is fine to make more goods with less labor, for example, until it's *your* job that is suddenly eliminated by a productive new machine.

By U.S. tradition — perhaps an artifact of the era when assembly lines and mass production were at the forefront of industrial development — productivity is measured as a ratio reflecting the amount of production per man-hour of work. But today a ratio based on the amount of production per unit of energy, or perhaps of raw materials, might have more meaning.

Almost by definition, the rate of productivity increase is greater in a developing nation than in a mature, industrialized society. We know that the rate of productivity increase in the U.S. since 1947 has been only about 3 per cent a year compared with 6 to 14 per cent in many other industrial nations — notably Japan and Western Europe. But is this statistic simply a natural, inevitable consequence of our relative maturity, or should it be a cause for alarm?

How do you measure the productivity of a service industry, whose output is not hardware but a "social good"? Does a computer which makes possible production of automobiles in 20 colors with 15 trim styles, each one consistent with its owner's sense of aesthetics but no more truly useful than the next, really enhance the productivity of the manufacturing plant which it serves?

Such questions motivated a workshop on manufacturing productivity at M.I.T. late last year. Some of the 80 experts who came may have thought that they would be talking mostly about machine tools, computers, process planning, automation, and foreign competition.

Indeed, ideas about computer-aided design and computer-aided manufacture have been around a long time — numerically-controlled machine tools were in M.I.T. laboratories in the 1950s, and so were computers dedicated to problems in kinematics and design. But truly widespread applications are still awaited. Nathan H. Cook, Professor of Mechanical

Engineering at M.I.T., suggested one reason: "We don't yet know enough" (*see box on page 20*).

If improved productivity is to result from improved technology, then innovation is a crucial factor. J. Herbert Hollomon, director of M.I.T.'s Center for Policy Alternatives, proposes that the seeds of low productivity were sown in the U.S. after World War II when, "we were mesmerized into thinking that the way to get new products was simply to do research and development." But defense and space research — which is mostly what was done in those years — isn't much help. To be useful in increasing productivity, research and development must focus on areas where technological change is known to be needed.

Congress knew that once. Fifty years earlier, when the U.S. sought to increase agricultural productivity, it did so by creating agricultural research stations and committing the universities to working closely with farmers on farmers' problems. ["The important thing is that they could talk to the farmer and learn how he raised pigs," said Professor Hollomon. "So now on the Cornell campus, they grow pigs!" (laughter).]

Dr. Hollomon thinks that most of the increase in U.S. productivity in this century has come through improvements in agriculture. Even from 1965 to 1972, he said, agricultural productivity was increasing at the rate of 5 to 7 per cent a year while that in manufacturing was growing at only 2 to 4 per cent annually.

But then human factors begin to complicate the picture. That growth of agricultural productivity resulted in "one of the largest emigrations ever seen in the world," when 35 million people moved from U.S. farms to U.S. cities. Result: urban problems and social trauma which will be with us "for generations," said Professor Hollomon.

Then he moved on to the case of coal: "The amount of coal mined per unit of capital and labor in Appalachia is higher than any other place in the world, higher than in England by a factor of five. . . . But what are the social costs of that productivity?" he asked.

Yet when push comes to shove, Dr. Hollomon joins the chorus: "If this country is going to increase its wealth to deal with its social problems, pay for its energy, and solve the problem of its unemployed, its productivity will have to increase."

How will that happen?

Many workshop speakers urged more incentives and rewards for innovation and increasing investments in research. "Advances in manufacturing productivity are a major subset of technological innovation," said R. M. Colton, Program Manager at the National Science Foundation, and a poor showing in innovation is bound inextricably to weakened domestic production and weakened international competitiveness.

But M.I.T.'s President Jerome B. Wiesner suggested that the issue goes far beyond technological problems involved in making goods faster and cheaper. The stumbling blocks are in economic, human, and social issues which cannot be understood by simply extrapolating from the past into the future.

Professor John T. Dunlop of Harvard agreed: the problem of productivity, he told the workshop, has to do more with building new institutions, new policies, and new relationships than with building new technology.

Professor Dunlop spoke with concern about the low level of expenditure by U.S. industry since 1975 on plant and equipment — " a very serious matter," he said, "a very unhealthy situation." George H. Kuper, Executive Director of the National Center for Productivity and Quality of Working Life, extended Professor Dunlop's worries: even in 1973 67 per cent of U.S. metalworking machinery was over ten years old; in other countries the percentages were sharply lower: in the U.K., 58 per cent; in Italy, 50 per cent; and in Japan and West Germany, 33 per cent. Continued low investment by U.S. industry adds to its handicap, since new machine tools are likely to be automated — and thus far more productive than their predecessors.

Why this low rate of new industrial investment in the U.S.? Uncertainty is a significant constraint, said Professor Dunlop; the business community simply doesn't know what to expect. There is uncertainty about energy resources and policy, a "cloud of indecision" on tax "reform" (Will there be a new structure for calculating capital gains taxes, or perhaps reduced taxes on investments?), and uneasiness about future regulatory policies. And then there is the haunting issue of international payments: "The failure to develop in the world any kind of systematic approach to our balance of payment problems is an absolutely eroding factor, and is likely to continue to be," said Professor Dunlop.

The lack of U.S. programs for helping with displaced workers is a significant constraint on improvement in manufacturing, said Dr. Hollomon. "Every major country in the world except the U.S. has policies and programs for handling the displacement of workers, including retraining and relocation," he declared. Instead, in the U.S. we adopt policies of no layoffs, reductions only by attrition; and this burdens the industry whose productivity we are trying to increase with ever more unproductive workers.

Another problem: manufacturing technology has lacked "status" and "glamour" as a field for study. "By and large," Professor Herbert H. Richardson, Head of the M.I.T. Department of Mechanical Engineering, told the workshop, "the manufacturing sector has not attracted its share of the nation's very best talent." It's been "out-glamoured" by aerospace, coupled only weakly with the more "acceptable" disciplines of design, computer science, and now "artificial intelligence."

The workshop's blueprint for the future called for closer links between science and the factory, a new thrust by government — because it can come from nowhere else — to help fragmented industries tap technological resources which no single company among them is strong enough to use. Professor Dunlop spoke of "new linkages and new institutions, a major reconstruction of the process of transferring technology from laboratory to the workfloor."

A model from M.I.T Professor Nam P. Suh, the Director of the Institute's new Laboratory for Manufacturing and Productivity whose opening was being celebrated: since 1973 he's directed a cooperative program in polymer processing technology to help subscriber companies — typically small units in a highly fragmented industry — solve technical problems. The firms, having overcome the psychological barrier of supporting "academic" research, now provide $540,000 a year, and new technology generated at M.I.T. is improving the productivity and profitability of all 12 participating companies.

In mature economies and industries, productivity is a hard thing to leverage. Large firms are stable and have large inertia; changes are likely to be costly and traumatic. But it is in just such firms, insensitive to new technology and inflexible in their responses to innovative opportunities, where the needs and opportunities are greatest, where improved productivity would most quickly improve market penetration and permit further improvements in productivity. When such a frustration is embedded in economic and social issues, there are no obviously simple solutions. — *J.M.* □

Computers Move Into Factories

What is the computer's role in a manufacturing industry, today and tomorrow?

To answer that question, Professor Nathan H. Cook of M.I.T. draws this map of a manufacturing system (*right*), showing a vertical flow of materials and a horizontal flow of information. Computers are working their way in from the outside toward the middle, he says.

The operations on the periphery of the diagram, he told an M.I.T. workshop on productivity late last year, are those in which "basic concepts are relatively simple and the work mostly involves quantified, numerical information." For example, accounting, part of the "finance" box which involves tedious, exacting handling of numbers, is an "ideal spot for computerization," said Professor Cook.

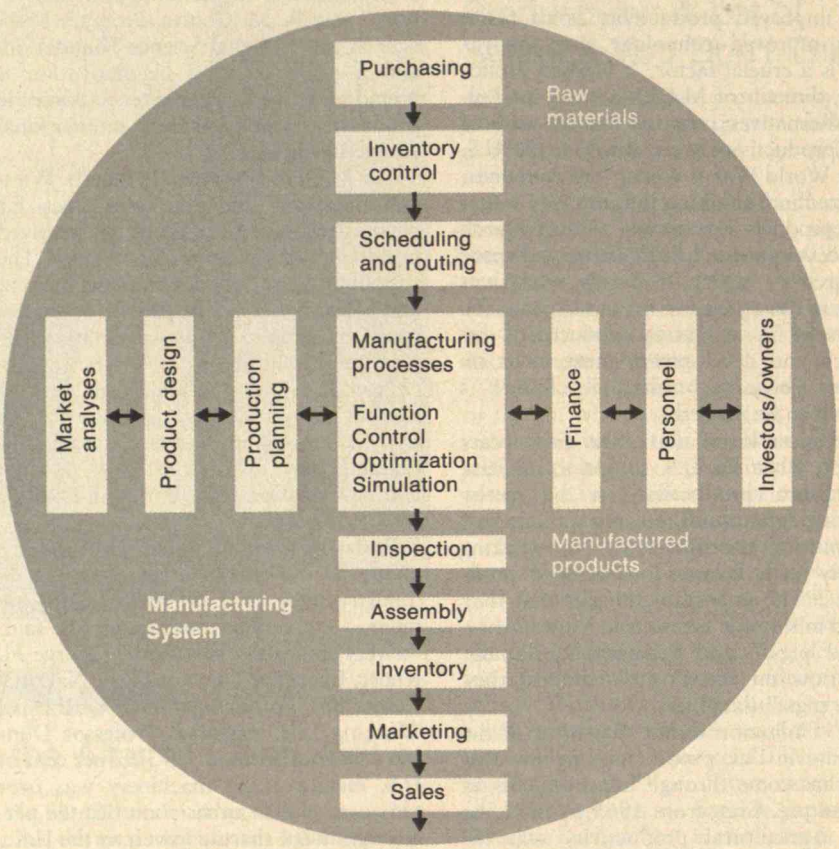
But moving toward the center of the chart, Professor Cook comes to product design, where computerization is "in its infancy." Here decisions have traditionally been made on the basis of "experience, intuition, judgment — even trial-and-error and guessing." That's because "the modelling and analysis which must precede computer application do not exist in a thorough, logical form," he said. Only in a few specific cases — involving familiar, well-established principles such as stress analysis and heat transfer — are computers likely to be effective design tools, and "it will be a long time before we are able to automatically design nonstandard parts and systems." Here is how Dr. Cook thinks computers may penetrate other functions on his chart:

☐ *Production planning:* "For years it has been clear that the computer should permit close interaction among design, production planning, and manufacturing. But we have not been able to close this loop in any but the simplest areas . . . and we have not been able to automate process planning."

☐ *Manufacturing:* Decisions about a production process — which machine to use, how fast to run it, and so forth — depend on the type of material, tooling, desired quality, and other similar parameters. "Although we have the greatest manufacturing base in the world and have been producing products for literally centuries, we do not have a database to support computerizing such decisions." And the problems are so complex and the alternatives so many that we may have to settle for "approximate methods which can be improved with time. . . . On the other hand, I anticipate improved methods for controlling process failure through tooling maintenance and failure diagnostics. Our basic understanding is fairly good, but we need more process sensors."

☐ *Management:* "Scheduling, routing, purchasing, and inventory control are being handled by computer, but generally not very well. In high volume production, where alternatives are few and the total system highly structured, a good job is done. In the job-shop environment, where alternatives and decisions are many and the system is very loosely structured, these functions are not too well done. We *may* in the future develop computerized methods sufficiently general to handle the great variety of unstructured job-shop problems. But I believe we are more apt to move to more structured, more specialized 'job shops,' where the choices are fewer and more amenable to good control."

☐ *Manufacturing systems:* "one of the computer's major contributions is the ability to model, analyze, and control the total manufacturing system as an entity rather than controlling a series of individual machines. As systems become more structured and highly automated, we will be able to carry out real-time system control." — *J.M.* ☐



Are We Ready for the Computerized Factory?

One of the most ambitious efforts ever made to systematically increase industrial productivity in the U.S. is now being mounted by the Air Force, which seeks to bring a system of integrated computer-aided manufacturing (I.C.A.M.) to the entire aerospace industry. The goal is to bring the enormous capability of computers in organizing, controlling, and communicating information to bear on every possible aspect of aircraft manufacture.

Will it work? And what will be the results?

No one can be sure, of course. But Robert T. Lund and his associates at the M.I.T. Center for Policy Alternatives are optimistic. Metal-forming, for example, is one of the principal areas of I.C.A.M. interest, and Dr. Lund's group concludes that "large percentages of formed parts" made and used in the aircraft industry should be amenable to manufacture in computer-managed processing systems.

This conclusion is part of a scenario on which C.P.A. built several hypotheses on the likely social and economic consequences of I.C.A.M. Mr. Lund and his group drew heavily on the record of a similar Air Force effort to increase productivity through the development of numerically-controlled machine tools at M.I.T. and elsewhere in the 1950s. Though there were problems and frustrations, the fact is that in less than a decade, by 1960, the new technology was in wide use in aerospace firms doing work for the Defense Department. On the whole, says Mr. Lund, the Air Force achieved "a remarkable transformation of manufacturing technology."

It will be the same with I.C.A.M., says the C.P.A. scenario. The benefits of I.C.A.M. will be easily perceived, and its adoption in producing military aircraft will be "relatively rapid" (perhaps a decade).

One reason is that I.C.A.M. could result in "a significant reduction in the total number of metal-forming workers employed for a given level of output." By significant, they mean reductions of 50 to 75 per cent in workers on a given process. But as it reduces the numbers, I.C.A.M. may also change the profile of jobs in aerospace metal-forming technology. Today most tasks require "moderately skilled" people, but with I.C.A.M. in place these moderate-skilled jobs will give way to fewer jobs in high- and low-skill categories — the higher-skill people being in programming and maintenance, the low-skill workers being parts-feeders and tool-changers. If this means fewer moderate-skill jobs, it will mean less upward mobility for low-skill workers and "a stratification of the workforce that might have undesirable consequences."

Whether the I.C.A.M. system promotes or discourages job satisfaction will depend more on its design than on the supervisors who are on the floor where it operates. "An early appreciation of the system designers' responsibility for creating meaningful jobs related to the new technology" will be important, say Dr. Lund and his co-workers. This applies to middle management as well as to the skilled and unskilled workers who will be on the floor, for I.C.A.M. is likely to bring them changes in responsibilities and operating procedures. The automation represented by I.C.A.M. will make the aerospace industry more capital-intensive and more tightly coupled from fabrication through assembly — more like the chemical industry. For example, where a few workers tend extensive processes they have "enormous leverage" on company policy; so I.C.A.M. may make the aerospace industry more vulnerable to the labor unrest which displacement and stratification may invite, and good management-worker relations will be essential.

Another potential problem proposed by Mr. Lund and his associates: computer control systems, which are "susceptible to partial or complete failure," may lead to "erratic machine behavior" of a kind unknown with conventional controls. Because worker health and safety standards are higher today than ever before, corporate liability problems may be serious.

Current capacity in the aerospace industry is double current demand, and capacity may further increase in the 1980s. This issue of overcapacity is "potentially serious" for wide acceptance of I.C.A.M. in the industry, and diffusion of I.C.A.M. outside the industry probably depends on how well it does inside.

The history of numerically-controlled machine tools may hold a warning. "Although it has been estimated that 75 per cent of metalworking tasks deal with small to medium batch runs, less than 2 per cent of machine tools are today equipped with numerical controls," write Dr. Lund and his co-workers. "The market is far from saturated (and) it is clear that a great many companies are still (even 20 years after their general acceptance in the aviation industry) unwilling to take the risk of purchasing new manufacturing systems. — *J.M.* □

Oceans

Nodules: Still Secure in the Deep

Remember those curious lumps of mineral — manganese, copper, nickel, and cobalt — that lie scattered over the deep ocean floor in the Eastern Pacific, and probably in lots of other places, too?

They're still there.

The reason for our failure to exploit this remarkable resource is curiously hard to determine. One hypothesis is that we don't yet need the nodules enough — meaning that metal prices are too low. Another is that we can't solve the thorny problems of collecting, hoisting, transporting, and processing. Still a third blames our inaction on the fact that the Law of the Sea Conference has yet to decide on a plan for licensing this international offshore resource.

Five industrial consortia have been formed to bring together the large amounts of capital and technology necessary to collect and process manganese nodules. All have or will soon have completed design and testing of pilot-scale recovery and processing systems, but none has yet embarked on the expensive business of scaling up its system to achieve the production that everyone agrees will be necessary for profitability. That target is the ability to separate 5,000 to 15,000 tons of nodules a day from the mid-Pacific sand or mud in which they lie, hoist them from the sea floor to a mineship, transfer them from the mineship to a carrier, and deliver them to an onshore processing plant.

C. Richard Tinsley, Second Vice President of the Continental Bank of Chicago, thinks the problem is financial. His analysis for the Oceans '78 conference of the Marine Technology Society places the capital requirement for a successful system at between $500 million and $1 billion — a large investment for even a powerful industrial consortium at a time when interest rates are high and metal prices weak. His estimates show rates of return averaging only 5 to 7 per cent a year. But he admits that the situation is volatile: the U.S. depends heavily on Zaire, Zambia, South Africa, and Rhodesia for its supplies of the minerals which could otherwise be obtained from the nodules, and what will happen to the mineral industries in those lands in the next half-decade is anybody's guess. It all adds up to lots of uncertainty and "me-too-ism" in the investment commitments that these

consortia now hold, Mr. Tinsley told Oceans '78; if one major investor should drop out, many others might also suddenly get cold feet and withdraw.

John E. Flipse, who headed Deepsea Ventures, Inc. — one of the nodule-recovery consortia — until about a year ago, admits all this; but he also stresses the significant technological problems that are associated with large-scale nodule recovery. Not one of the consortia which has completed its small-scale tests turned off its mining machine, Professor Flipse (he's now teaching at Texas A. and M. University) told the Oceans '78 conference. The tests ended when the machines broke down.

In their formal paper for the conference, Professors Flipse and John B. Herbich, Head of the Texas A. and M. Ocean Engineering Program, listed a series of technological constraints:

☐ We lack an accurate and dependable *in situ* survey system. Our present data on nodule concentrations come from samples taken at the end of a dragline whose location is known only imprecisely.

☐ "Technical problems abound" at the three interfaces of any ocean mining system. The mineship will have six kinds of motion — roll, pitch, yaw, heave, surge, and sway. The pipe connecting this moving platform to the dredge on the sea floor must somehow accommodate all of these while transporting very large tonnages of rock and (probably) volumes of water; that's one interface. There's a similar problem at the interface between dredge and sea floor, and there's an even more complicated interface between the mineship and the bulk carrier, each of which will have these six degrees of freedom of motion.

☐ "No discussion of electricity at sea can be complete without noting the delays and frustrations caused by cursed connectors," write Professors Flipse and Herbich. "There is no lack of effort, nor accompanying increase in cost, on the part of the manufacturers, installers and users; but any component that depends upon the absence of a hair or particle of lint under the O-ring and the artistic application of a 'smidge' of grease (of the proper type, naturally) in field use must represent a technological gap."

☐ There are also some serious control problems. The mineship will of necessity be moving slowly as its dredge is pulled across the sea floor. Put this ship in a random sea, and attach to it "through a 'soft' connection three miles of steel pipe and cable with a ten-ton vehicle at its end to be towed over uncertain terrain of variable load-bearing characteristics and we further complicate the total vehicle control problem," write Professors Herbich and Flipse. "In spite of the prototype tests performed, much analysis, modeling and optimization remain to be done before an efficient commercial system can be designed, built and placed in service."

Meanwhile, what of the political issues which have until now discouraged nodule exploitation simply because there was no way to establish ownership of a resource on the bottom of the Pacific Ocean far from land? Curiously, even while financial and technological problems compound uncertainty, a computer-based model that seems to dismiss these by predicting generous returns on investment may be resolving the legalities.

The model is the work of Professor J. Daniel Nyhart and several of his students in M.I.T.'s Sloan School of Management. It proposes that returns to exploiters of the nodules may be in the 15-per-cent range, and its hard numbers have been embraced by weary negotiators in the current Law of the Sea Conference. Clearly they will opt for some kind of international authority which receives rents and royalties from nodule miners, and now Professor Nyhart's model is quantifying the rewards that may be available for distribution among owners and exploiters.

Mr. Tinsley was skeptical. He noted that Professor Nyhart's model-building was supported by the U.S. Sea Grant program and N.O.A.A., and he expressed his concern: "Should the U.S. government," he asked, "act to provide data which will set the rate of return on investment to be earned by a U.S. company?" — *J.M.* ☐

Manned aircraft are the least expensive of the several alternatives for ocean surveillance to enforce the new 200-mile economic zone. One Coast Guard estimate for the present cost of surveillance is $25 per square mile per year. (Data: N. L. Stone)

	Search area covered (sq.mi./hr.)	Total operation costs (dollars per sq.mi./yr.)	Initial cost (dollars)	Revisit time
Aircraft (manned)	10^5	3.50	6×10^6	1 day
Helicopter	2×10^4	7-	2×10^6	1 day
Ship (displacement hull)	3×10^2	1000	2×10^7	Days
Radar satellite (multiple low orbit)	3×10^7	2800	5×10^7	4 hrs.
Anchored buoy	3×12^2	60	10^4	Constant (fixed area)
Shore station	2×10^4	250	5×10^6	Constant (fixed area)

Surveillance of the Seas: Methods and Costs

Economic sovereignty over 200 miles of ocean surrounding our coasts is an empty claim unless that territory can be watched and human interventions into it controlled. That turns out to require surveillance of some two million square miles of water, half of which is off Alaska and Hawaii — a large, expensive, and technically frustrating assignment, far more complex than military surveillance of an equivalent area.

The tools for the job include platforms (ships and aircraft, including helicoptors and satellites), unmanned sensors, and all kinds of communications. But none of these tools is ideal. Platforms are short-lived because they need frequent refueling and are often handicapped by weather, and our sensors are feeble indeed when compared with those we observe in nature but cannot understand, let alone duplicate.

Consider, for example, the feat of the male yellowfin, finding a female of the same species in the billions of cubic feet of water in the Pacific breeding grounds; we have no way to imagine how this prodigious task of search and identification is accomplished. Even when we are as close as 50 feet from a fishing trawler, we have no idea of the contents of its hold.

U.S. surveillance of our 200-mile economic zone — now principally devoted to enforcing fishing rules and combatting the transport of illicit drugs — relies chiefly on very conventional technology because it is by far the least expensive, says Norman L. Stone of the Ocean Systems Division of Sanders Associates. One can pro-

pose futuristic scenarios involving radar-equipped satellites and seeing-eye buoys, but when it comes to the practical question of doing the job best at least cost, there are just no alternatives for ships and aircraft.

One plane with appropriate radars can search an area of 100,000 square miles an hour at an annual cost of $3.50 per daily surveyed mile per year. A helicopter is a close second — 20,000 square miles an hour, $7 per daily surveyed mile per year. Satellite-mounted "eyes" cannot compete at all; though a satellite's coverage is enormous — 3 million square miles an hour — the cost is high: $2,800 to survey a square mile every four hours for a year, Norman L. Stone reported at the Marine Technology Society's Oceans '78 conference in Washington this fall.

Control requires people, and that means boats. Mr. Stone puts the cost of surveillance from a conventional Coast Guard patrol ship at $1,000 per square mile per year, and just over 100 of them were available last year. That compares with 700 foreign fishing vessels off Alaska alone last June.

Systems concepts — airborne and buoy-mounted radars and communications interceptors reporting automatically to control centers — multiply the effectiveness of these components. But the task is both large and complex, and Mr. Stone thinks, "a more rigorous estimate of the relationship between enforcement, surveillance, and economic return," is needed. "Lest we grow too fond of technological solutions," Mr. Stone told his audience of marine engineers to keep in mind that a 100-man shipboard observer program that would put an observer on nearly every foreign fishing vessel off New England would cost about $5,000 million. Compared with this high cost, the $5 million initial cost of a single surveillance aircraft, even with operating costs added, sounds like a good investment.— *J.M.* □

New Look for Fishing

Is the U.S. fishing industry poised on the brink of disaster — or is it facing a bright future with new technology to exploit the fishing resources of the 200-mile economic zone over which the U.S. now has jurisdiction?

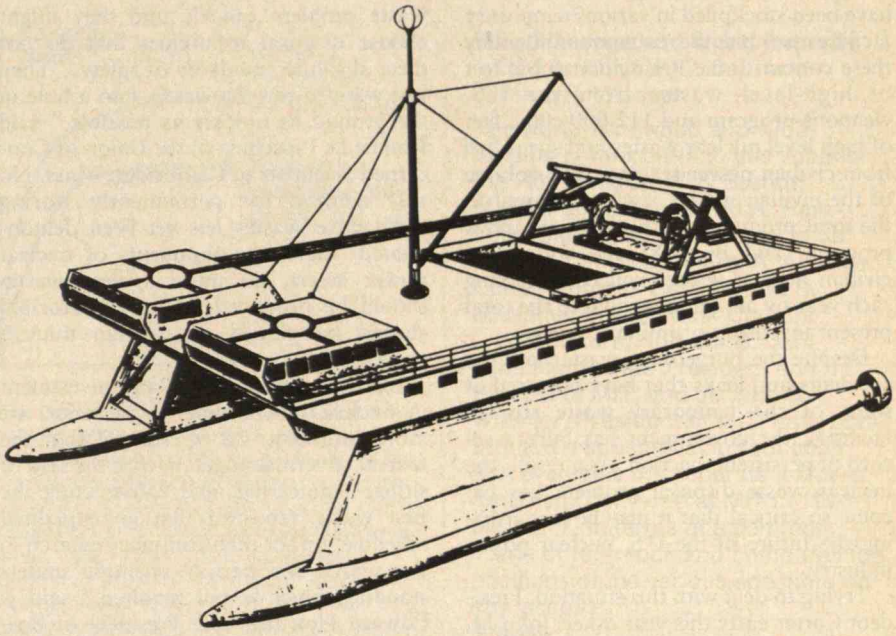
The question can be answered either way, and some observers seem to answer it both ways at once. Almost everyone blames the fisheries' future ills — if any are forecast — on the U.S. government.

Professor Giulio Pontecorvo of Columbia University says expansion of the U.S. fishing industry is possible only if Americans can learn to eat seafood which they don't now demand — species in plentiful supply but unwanted in today's marketplace. The supply now being harvested is inelastic, and no one can make a glowing forecast for an industry whose resources for growth are thus limited.

But on the other side of Professor Pontecorvo's mirrored ball is the growing world scarcity of protein: as the price of protein rises, the value of our fish stocks automatically increases apace.

Fishermen are now presented with a series of tricky management problems they are ill-equipped to resolve, Professor Pontecorvo told the Oceans '78 conference of the Marine Technology Society this fall: Shall they accept U.S. restrictions on present catches to assure supplies for a future when protein will be scarcer and command more money? Can they learn to live with quotas, fishing first for cod and the next week (or day), because the cod quota is filled, for haddock? To operate in an arena where questions like these are at stake requires more information and more capability to respond than can be justified by today's fishing industry.

But tomorrow may be different. Lucy Sloan, who represents several fishermen's groups in Washington, thinks new capital may soon flow to the industry. "Investors are walking up and down the piers in Seattle with their pockets full of money," she told the Oceans '78 meeting, and only a little encouragement from the government on policies and consumers on prices will be needed before they dig in.



This twin-hulled semi-submersible concept may soon revolutionize Hawaiians' ideas of what a fishing boat should look like. SEACO, Inc., of Kailua, hopes to build this 300-ton, 96-foot-long version of a navy design by 1980. It will provide a wide expanse of deck and at the same time offer greater stability and maneuverability than conventional hulls, designers Mark S. Rice and Jack Harmon told the Oceans '78 conference this fall.

When that time comes, Mark Rice and Jack Harmon of SEACO, Inc., of Kailua, Hawaii, will be ready. They are busily adapting the Navy's concept of a twin-hulled semi-submerged platform (S.S.P. Kailalino) to fishermen's needs; the result by 1980, they told Oceans '78, will be a revolutionary 300-ton vessel which will look like no fishing boat ever built before — a platform sitting on two parallel submerged cylinders containing flotation and motive power. It will be spacious (96 feet long), maneuverable (two propellers set 50 feet apart), fast (16 knots), steady, dependable, and versatile — fully capable of tapping the 800,000 square miles of fishing ground within 200 miles of the Hawaiian Islands.

The cost of such a vessel, says SEACO, will be $2.5 million; but its operating costs will be nominal — $18 per mile while fishing, leading to a breakeven point of 12 cents per pound of fish caught on a successful trip. — *J.M.* □

Nuclear Power

Nuclear Waste and the Looking Good Syndrome

Is it possible to isolate highly toxic radioactive wastes from the biosphere for tens of thousands of years until the radionuclides have decayed to innocuous levels?

For the past three decades, the U.S. government has failed to produce an acceptable answer. Meanwhile, nuclear wastes

have been stockpiled in various temporary facilities around the country until today these contain some 9.4 million cubic feet of high-level wastes from the U.S. weapons program and 112,000 cubic feet of high level nuclear wastes and spent fuel from civilian power reactors. The volume of the civilian wastes is already equal to the total produced by the entire weapons program, and by 1985 the volume of civilian nuclear wastes will be increasing each year by an amount equal to the total present inventory of military wastes.

Despite the burgeoning wastes and the accidents and leaks that have occurred at some of the temporary waste storage facilities, the government has built a record of persistent inaction. As a result, the nuclear waste disposal problem has become so critical that it may be jeopardizing the future of the U.S. nuclear power industry.

Trying to deal with this situation, President Carter early this year asked John M. Deutch, who is on leave from his position as Professor of Chemistry at M.I.T. to head the Office of Energy Research at the Department of Energy, to lead an Interagency Review Group (I.R.G.). The President wanted recommendations (due October 1) on a bewildering array of unresolved questions:

☐ What are the best ways to dispose of nuclear wastes?

☐ How much will disposal cost?

☐ What effects will disposal have on the environment?

☐ What standards of safety should be attained?

☐ What should be the roles and responsibilities of the states and of the federal government, especially in transporting radioactive materials across state lines?

☐ Should the U.S. store and dispose of spent fuel from foreign reactors?

The President suggested that the I.R.G. involve the public in shaping its recommendations, and for this purpose the I.R.G. has already held three public forums. One hundred witnesses, including the familiar local divided crowd that has been contributing to the nuclear debate for years, appeared at the Boston hearings late in the summer.

One might think that much of the nuclear waste issue could be resolved by a conclusive demonstration of technical feasibility to store the wastes safely; but everybody defines "safely" in a different fashion. Nuclear critics point out that the risks associated with the disposal of nuclear wastes are underestimated. The government and the industry, they argue, have a major stake in resolving the nuclear waste problem quickly and they might choose disposal techniques that do not meet absolute standards of safety. "They just want to put the wastes into a hole in the ground as quickly as possible," said Ronnie D. Lipschutz of the Union of Concerned Scientists in Cambridge, Mass. No safe method for permanently storing radioactive wastes has yet been demonstrated; therefore, opponents of nuclear power assert, no more nuclear wastes should be produced, and a moratorium should be placed on civilian nuclear power.

Electric utilities, whose large investment in nuclear power may be at stake, are more confident: "It is essential that the federal government get on with the task of siting, engineering, and constructing the first waste repository on an expedited schedule, rather than continue research in the search for perfect scientific understanding which is not required," said J. Edward Howard, Vice President of Boston Edison Co. "The engineering design is available now," he added.

The present outlook for electric utilities is gloomy. The ban on reprocessing imposed recently by the Carter administration has left them with nothing to do with the spent fuel which is discharged about three times each year from an operating power plant. This spent fuel is piling up in the storage pools at the power plant sites. The utilities claim that unless additional storage facilities are built in the near future — either on site, or away from the reactors — nuclear power plants will have to shut down in the mid-1980s. Because nuclear power already supplies more than one third of the electricity in certain parts of the country, such a shutdown would create a major national crisis.

David J. Rose, Professor of Nuclear Engineering at M.I.T., thinks the present impasse results from what he calls "the 'looking-good' syndrome." Too many people have for too long been "more concerned with looking good than doing good," he told I.R.G.'s Boston hearing.

Even a decade ago it was clear to him, Dr. Rose said, that the nuclear waste problem "was being handled in a manner that would lead to trouble. . . . [It] wasn't being properly explained to the public, the Congress, or to other groups. The reason was that those outside the program had insufficient knowledge, and those inside were adjured by considerable pressure . . . to keep as low a profile as possible."

It's been that way ever since. The "looking-good syndrome" "appears throughout the bureaucracy, where the challenge is to find an ecological niche or study space in which to fit one more report. . . . This space, like Hilbert space," said Professor Rose, "has lots of room, and as more studies get done more room exists for combinations of them."

Today's emphasis of studies, impact statements, and rule-making is a way of continuing the "looking-good syndrome," said Professor Rose. Satisfying bureaucratic and regulatory commitments takes time, and court challenges can "stretch out forever." All this serves to distract us from what Dr. Rose said is the main issue: "to get some kind of public consensus on what to do.

"It takes some guts to speak about the institutional failures, the lack of leadership, the self-serving arguments, and the hidden agendas. . . . It is time for those in high authority to be more eloquent, and more blunt."

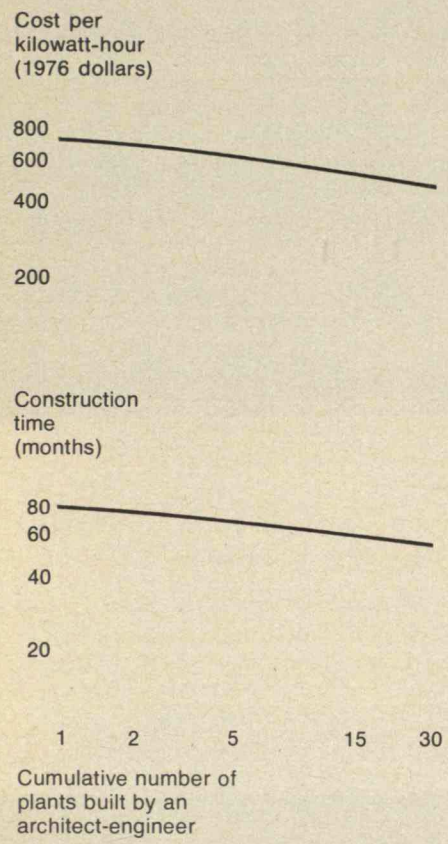
Advocates of nuclear power, and opponents as well, understand that the nuclear waste management issue has the potential for bringing the nation's nuclear power program to a complete and indefinite stop. Both parties expressed skepticism throughout the Boston hearings about the government's ability to solve the waste disposal problem. Members of the I.R.G. panel acknowledge the need to restore public confidence before attempting to implement a policy, a delicate mission indeed. — *Odile Disch* ☐

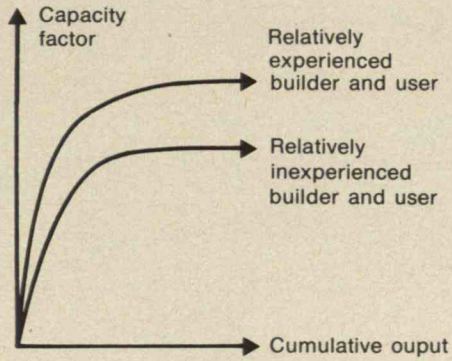
The Nuclear Learning Curve

The idea of a "learning curve" in the manufacture and use of conventional technology is well understood: the productivity of almost any technologically-based enterprise improves in both quality and quantity as its workers become familiar with their tasks and its users with the products. It's now clear that the same learning processes are experienced by the makers and users of nuclear reactors:

☐ An analysis by Professors Paul L. Joskow and George A. Rozanski of M.I.T. shows a "learning curve" for nuclear plants in operation in 1976 which extrapolates to an increase in electricity production at an average rate of about 5 per cent a year.

☐ Studying trends in the costs of building nuclear plants, William E. Mooz of Rand Corp. finds a "strong cost-learning effect," with construction costs, and time reduced by some 10 per cent per cent for each doubling of the number of plants built by a given architect-engineer.





The cost and time required to build a nuclear plant and how well that plant performs depend on the experience of the architect-engineer who designs it and the utility which operates it; it's the same kind of "learning curve" effect which is familiar in other, less sophisticated technologies. William E. Mooz of Rand Corp. finds (left) that doubling the number of plants built by a design-engineering firm reduces by about 10 per cent the cost and time required for construction. Professors Paul L. Joskow and George A. Rozanski of M.I.T. find that the reactor's ultimate capacity factor depends on the experience of its builder and that the speed with which the reactor is brought to that maximum capacity depends on the experience of the utility which operates it (above).

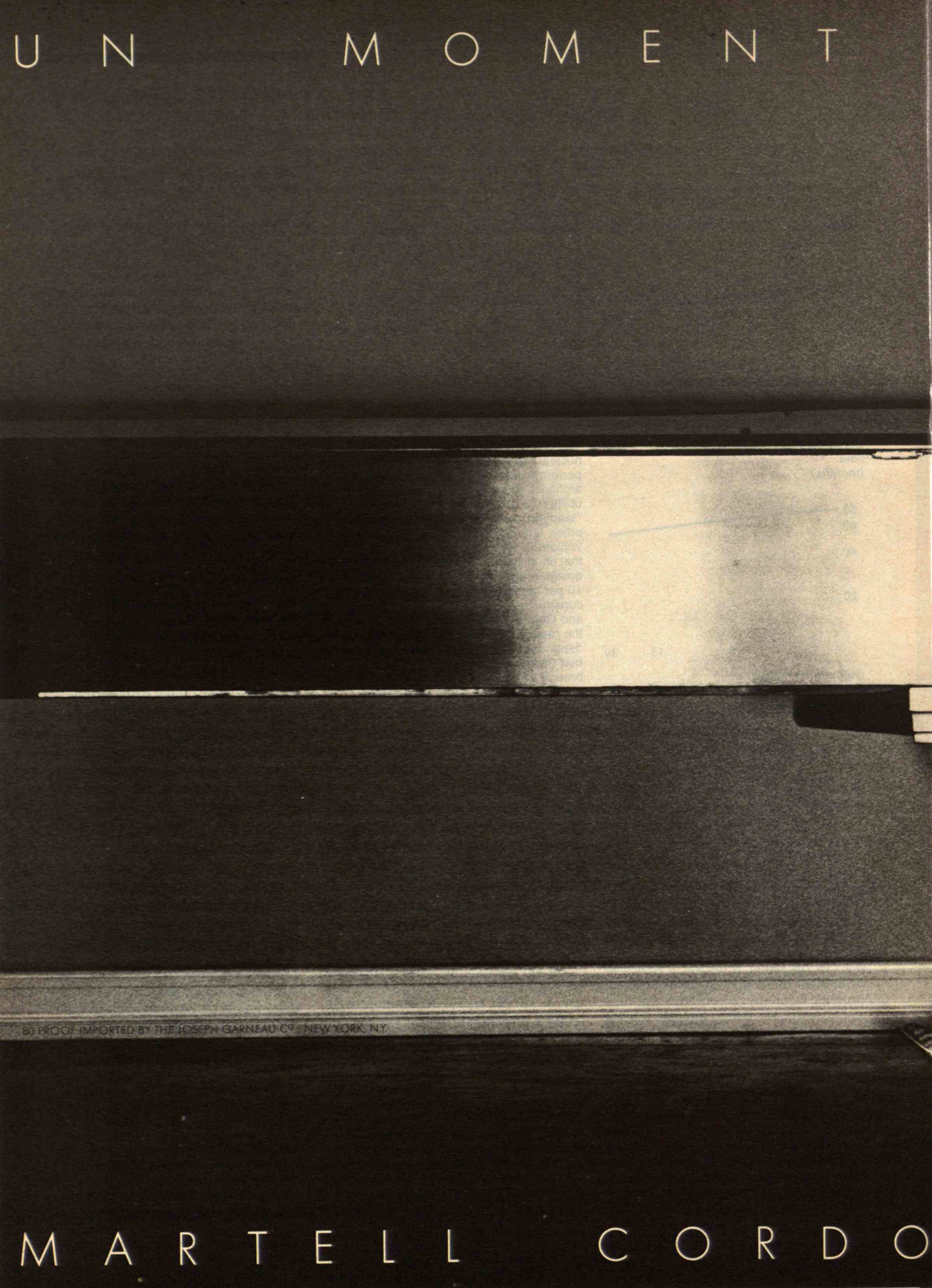
Examining the "capacity factor" — the proportion of actual electricity output to that theoretically possible — of nuclear plants in operation in 1976, Professors Joskow and Rozanski conclude that the "learning curve" affected both operators and producers of nuclear plants in commercial operation at the end of 1975. There are "significant and substantial" learning-curve effects for plant operators, they say, resulting in increasing electricity production over time as operators become familiar with the system. After two full years of operation, a nuclear reactor can be brought to 80 per cent of its eventual capacity factor by an effective operator and his crew; thereafter, progress toward the final goal is slower but steady.

This final maximum capacity factor depends less on the operators than the builder of a reactor, according to the analysis; an additional year of design and construction experience increases the ultimately realizable capacity factor by about 5 per cent. Larger reactors tend to be less dependable than smaller ones — as of 1976, increasing the unit size from 600 to 1,000 megawatts reduced the capacity factor by nearly 15 per cent.

Two other ways of demonstrating that a learning curve applies to reactor architect-engineers emerges from the Rand Corp. study: doubling the number of plants built by such a firm reduces the cost of the last plant built by about $55 per kilowatt of capacity and the time required for its construction to about 90 per cent of what it was previously. It is clear to Dr. Mooz that the architect-engineer through his cumulative experience "gains insights into methods of reducing both construction time and cost."

The key question for today is suggested but not answered. The last half of the current decade has been a twilight time of decreasing orders and increasing despondency for the U.S. nuclear industry; the demand for electrical energy has unexpectedly flattened, government policy has seemed ambivalent, and public confidence has weakened.

Should the pendulum swing back, bringing fresh demand for the design and engineering of nuclear plants, could the U.S. nuclear industry maintain the levels of productivity achieved in the early 1970s and resume the rate of productivity increase which then prevailed? — *J.M.* □


UN MOMENT
80 PROOF IMPORTED BY THE JOSEPH GARNEAU Co., NEW YORK, N.Y.
MARTELL CORDO


DE MARTELL
MARTELL
N BLEU COGNAC

Discarded Automobiles

Automotive Scrap Recycling — Processes, Prices, & Prospects
James W. Sawyer, Jr.
Washington, D.C.: Resources for the Future, distributed by the Johns Hopkins University Press, 1974, xvi + 141 pp.; $7.50
Cars, Cans, and Dumps: Solutions for Rural Residuals
F. Lee Brown and A. O. Lebeck
Baltimore, Md.: The Johns Hopkins University Press, publishers for Resources for the Future, 1976, xiv + 206 pp.; $12.95

Reviewed by Michael B. Bever and David C. Major

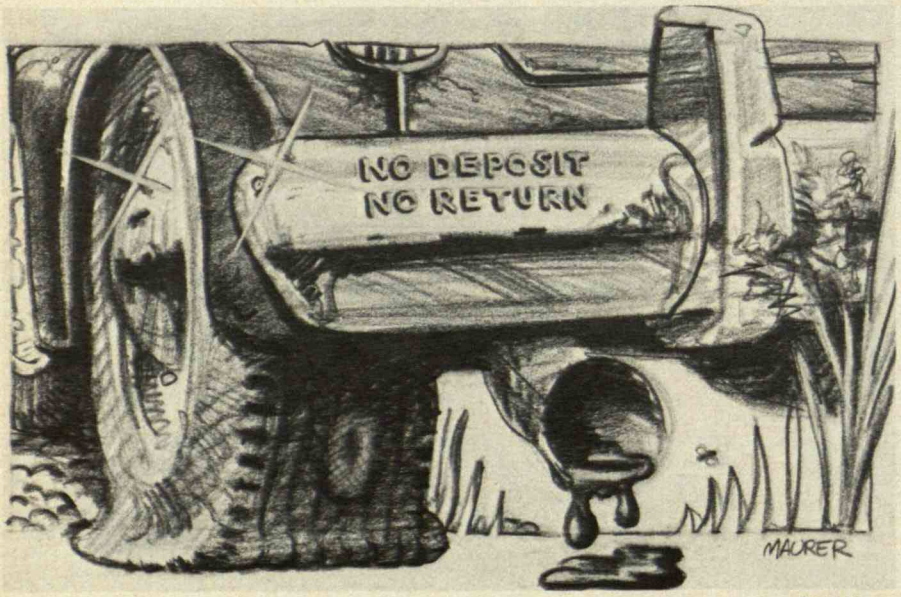
Over 100 million automobiles are on the road in the U.S. and each year, 7 to 9 million are discarded. A medium-sized car in current use contains over 2,300 lbs. of steel and at least 600 lbs. of cast iron. Thus the ferrous materials in automobiles that could be recycled by the steel and cast-iron foundry industries amount to 10 to 13 million tons per year. And the million trucks scrapped each year account for about 2 million additional tons of ferrous materials, yielding a maximum potential resource of 12 to 15 million tons in a typical year.

The fraction of materials other than iron and steel in discarded automobiles that might also be exploited will continue to increase. But at present, recovering the ferrous materials that are the hulks' main components after the removal of reusable parts is the major function of the automobile recycling industry.

Dismantling and Shredding

Only a few procedures are available for the disposal of discarded automobiles. Partial disassembly or dismantling of cars is carried out by wreckers who remove reusable parts, but total disassembly of all cars for the recovery of materials is too expensive in the United States to be practical. One traditional method — baling — consists simply of compacting; another method is compressing and shearing. But these methods do not provide for the separation of the materials present in the car body. They waste nonferrous metals and produce scrap contaminated by copper — especially harmful if ferrous scrap is used in steelmaking.

The best current technology for processing automobile hulks is the shredder. The central unit of a shredder plant is a hammermill or similar piece of equipment which tears the hulk into small pieces. The output of this unit is separated by further processing: the ferrous material is removed from the stream by electromagnets; the light materials such as fabrics and dust are eliminated as the "air fraction"; the remaining "heavy fraction" can be separated into its constituent nonferrous metals, stainless steel, rubber, and glass by heavy media separation or other techniques. In this way, aluminum alloys, zinc, copper and stainless steel are recovered as usable materials. The plastics can also be separated but to date their recovery has not been practical.



David Maurer

The shredder came into its own in the period of high demand for ferrous scrap in the early 1970s. But it does not fully resolve the junk automobile problem. Automobiles continue to be abandoned in places too distant from shredders to make their collection economical. Moreover, the domestic and international market forces that have encouraged the relative success of the shredder may change. The more fuel-efficient automobiles mandated by the federal government are going to be produced with increasing fractions of nonferrous and nonmetallic materials — in particular, aluminum and plastics. Since current shredder economics depend mainly on the revenues from ferrous scrap, the resulting reduction in ferrous materials will make the processing of hulks economically less attractive. The increasing use of low-alloy high-strength steels will create technical problems in the recycling of the ferrous fraction.

Incentives for Recycling

The process of moving a car from deregistration or abandonment to recovery involves a range of actors: the owner, several levels of government, the wrecking and scrap processing industries, and the automobile manufacturers. In this extended chain of influence it is difficult to establish a rational procedure since economic and other incentives are not operative at all stages, although recycling proceeds reasonably well when scrap demand is high. One solution might be a deposit paid at the time of the first purchase and refunded to the last owner as a reward for orderly disposal. Alternatively, some countries levy an annual tax on cars until their disposal is certified.

Given these circumstances, technical, economic and institutional studies of the junk automobile problem continue to be of interest. *Automotive Scrap Recycling* and *Cars, Cans, and Dumps* address the problem from different viewpoints.

Sawyer's book is an analytic study of the production of steel scrap from discarded automobiles, carried out within the framework of the microeconomic model of resource allocation. He concludes, based on the results of two mathematical programming models of the industry and qualitative analysis for the Philadelphia region, that the short-term (one to two year) elasticity of supply of scrap from discarded autos is quite high. He estimates this value to be five to ten, that is, each 1 per cent increase in the price of scrap per ton would result in a 5 to 10 per cent increase in tons of scrap supplied. This implies, as a policy conclusion, that a

"Another good thing made from petroleum: safer explosives. This is a new one, Slurran 819."

"I spend my days trying to make explosives go off by accident."

"I shoot holes in explosives with a 30-06 rifle," says Gulf Technician John Starrett. "I drop weights on them, drown them, hammer on them, burn them. Because if shock or heat or abrasion will make an explosive go off by accident, we want to find out here at our test ground, instead of on a job somewhere.

"An explosive that resists a shock like this will be safer to use in mines and quarries."

No two the same

"Of course, the best explosive is one that won't go off until you want it to, at the right time and in the right circumstances. It's one of the minor miracles of petroleum chemistry that you can come so close to the ideal.

"For instance, we made this new product, Slurran 819,™ a pourable slurry, to avoid the danger of packing solid explosives into confined spaces.

Fine-tuning

"Every new product has to go through a whole series of tests so we can design out characteristics that would make it hard to handle.

"It's a strange business, when you think about it, fine-tuning an explosive so it'll be safe to handle, but blow something all to pieces when you hook it up right.

"It's a real challenge, but if you don't mind my saying so, I get a bang out of it."

Gulf

Gulf people: meeting the challenge.

Gulf Oil Corporation.

good measure for dealing with junk automobiles would be to raise the demand for scrap and thus call forth a greatly increased supply. This would increase collections of abandoned autos. Raising the demand, however, will not, as Sawyer notes, necessarily be as effective as would appear at first sight. In some regions the supply may have attained or will soon reach the practical limit (that is, the supply curve becomes vertical); also, demand may reach a limit due to quality problems. These, however, are more significant with baled scrap — which appears to be declining as a fraction of auto scrap — than with shredder scrap, which has relatively high quality.

The framework that Sawyer has developed will be useful for engineers and planners concerned with developing the details of junk-auto management in a specific region. Sawyer also foresees that hand-dismantling, because of rising labor costs and quality control problems, will probably be limited in the future to very basic dismantling (radiator, heater core, and battery).

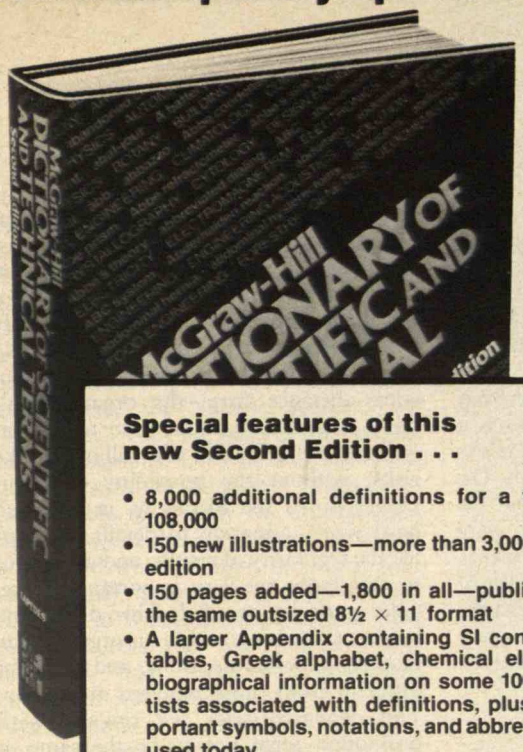
Collection in Rural Areas

Against the backdrop of New Mexico, Brown and Lebeck examine the problem of junk automobiles in rural areas. On the basis of a detailed survey of practical technologies, costs and institutional and political factors, they recommend for that state a mixed public/private program. The state would pay for the collection of abandoned vehicles and for their transportation to suitable collection centers. These activities are not privately profitable in New Mexico because of the wide scattering of abandoned vehicles. Once the vehicles are assembled at collection centers, the role of the state can end, since it is privately profitable to flatten groups of hulks and transport them to shredding facilities in Albuquerque.

The costs to the state of this continuing program would be financed from proceeds of a deposit on first-time registrations of vehicles in New Mexico, refunded if the vehicle has been disposed of in an environmentally acceptable way. The one-time collection of the present accumulation of hulks and their flattening and transport to shredding facilities would be entirely a state responsibility, since in Brown and Lebeck's view the magnitude of the inital collection as opposed to the continuing program could temporarily lower scrap prices sufficiently to make private participation unprofitable.

Brown and Lebeck use straightforward

Now a completely updated new edition of the unique reference acclaimed by users and reviewers* the world over . . .



McGraw-Hill DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS

Second Edition

Daniel N. Lapedes, Editor-in-Chief

Prepared by the Staff of the *McGraw-Hill Encyclopedia of Science and Technology* and a Board of 30 Contributing-Consulting Editors

Special features of this new Second Edition . . .

- 8,000 additional definitions for a total of 108,000
- 150 new illustrations—more than 3,000 in this edition
- 150 pages added—1,800 in all—published in the same outsized 8½ × 11 format
- A larger Appendix containing SI conversion tables, Greek alphabet, chemical elements, biographical information on some 100 scientists associated with definitions, plus all important symbols, notations, and abbreviations used today
- Includes new terms in traditional areas and specialized terms now coming into wider general use.

Reflecting the explosive growth of science and technology and the ever-expanding vocabulary it generates, this highly praised Dictionary—now in a new Second Edition—defines thousands upon thousands of terms in hundreds of fields. It is an indispensable tool for scientists, engineers, technicians, librarians, writers, and students. A truly comprehensive one-volume reference, the Dictionary contains scores of illustrations and employs the very latest terminology throughout—offering you significant reductions in research time, no matter where your interests may lie in the sciences, engineering, or industry.

A Model of Scholarship

All terms in the volume were selected and reviewed by a Board of Consultants, each from a particular branch of science or technology. Their absolute attention to detail and clarity puts all *basic* terms, plus all *new* terms, where you want and need them—*in a single, dependable volume that is at once instructive, functional, and illuminating.* With all of science and engineering covered in this single work, the Dictionary eliminates further searches through specialized books and articles, and saves you the cost of multiple reference materials. But even better, you don't have to wade through paragraphs of description. The Dictionary is in strict A-to-Z format, and cross-referenced for synonyms, acronyms, and abbreviations to avoid confusion when the same terms are applied to different processes, materials, or mechanisms.

As a busy professional, you owe it to yourself to examine this new edition and test it in every possible way. Ask to have a copy sent to you for 15 days on approval. See how it can save you valuable time—and meet your most demanding criteria for concise, reliable definitions.

Special Edition Also Available

A handsome deluxe edition—bound in high-quality buckram, thumb-indexed, and with gilt-edged pages—has been published simultaneously, and may be ordered by checking the appropriate box on the coupon below.

The major fields covered and identified with each entry . . .

Acoustics
Aerospace Engineering
Agriculture
Analytical Chemistry
Anatomy
Anthropology
Archeology
Architecture
Astronomy
Astrophysics
Atomic Physics
Automatic Data Processing
Biochemistry
Biology
Biophysics
Botany
Building Construction
Chemical Engineering
Chemistry
Civil Engineering
Climatology
Communications
Control Systems
Cryogenics
Crystalography
Cytology
Design Engineering
Ecology
Electricity
Electromagnetism
Electronics
Embryology
Engineering
Engineered Acoustics
Evolution
Fluid Mechanics
Food Engineering
Forestry
Genetics
Geochemistry
Geodesy
Geography
Geology
Geophysics
Graphic Arts
Histology
Horology
Hydrology
Immunology
Industrial Engineering
Inorganic Chemistry
Invertebrate Zoology
Lapidary
Mapping
Materials
Mathematics
Mechanical Engineering
Mechanics
Medicine
Metallurgy
Meteorology
Microbiology
Mineralogy
Mining Engineering
Molecular Biology
Mycology
Naval Architecture
Navigation
Nuclear Physics
Nucleonics
Oceanography
Optics
Ordnance
Organic Chemistry
Paleobotany
Paleontology
Pathology
Particle Physics
Petroleum Engineering
Petrology
Pharmacology
Physical Chemistry
Physics
Physiology
Plant Pathology
Plasma Physics
Psychology
Quantum Mechanics
Relativity
Solid-state Physics
Spectroscopy
Statistical Mechanics
Statistics
Systematics
Systems Engineering
Textiles
Thermodynamics
Vertebrate Zoology
Virology
Zoology

Heralded throughout the world, the Dictionary is now being translated into Arabic, Italian, Japanese, Spanish, and other languages—eloquent proof of its value to scientists and technicians in all fields, everywhere!

* **"A remarkably good buy."** ***—Chemical Engineering***

"No scientific or engineering office should be without a copy." ***—American Scientist***

"A genuinely indispensable reference for technical writers and editors, engineers, and anyone who needs clear, accurate information." ***—Plastics Engineering***

"Does a hard job superbly." ***—Popular Science***

"Fascinating . . . invaluable for all libraries and companies that must deal with the technical or scientific community." ***—AIChE Journal***

"Outstanding . . . recommended for all reference collections." ***—Library Journal***

"For scientists and generalists alike who wish to broaden their technical vocabulary without overburdening their shelf space." ***—Power Bookshelf***

"A definitive reference work." ***—Building Systems Design***

"Indispensable." ***—Business Week***

At bookstores or direct from publisher for 15 days' free examination.

McGraw-Hill Book Company
P.O. Box 400, Hightstown, New Jersey 08520

Please send me _____ copy (copies) of the McGraw-Hill DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS, Second Edition, (045258-X) for 15 days on approval. At the end of that time, I will either remit $39.50 for each copy ordered, plus tax, postage, and handling, or return the book(s) without further obligation.

☐ Check here for De Luxe Edition (045259-8), $49.50

Name _____

Address _____

City _____ State _____ Zip _____

SAVE MONEY! Remit with this order, plus local tax, and McGraw-Hill pays all regular postage and handling charges. Same 15-day return and refund privileges apply.

This offer good only in U.S. and is subject to acceptance by McGraw-Hill.

50-C720-4219-3

engineering and economic methods to arrive at their recommendations. While it is possible to disagree with one or another of the authors' cost and technological assumptions, their work is at a sufficient level of detail to make it a good starting point for a state legislative committee or environmental group desiring to formulate policy for junk automobiles in rural areas. Among the useful features of the book are a description of an aerial sample survey of accumulated hulks, a proposed abandoned vehicle statute, and a bibliography. (Brown and Lebeck also analyze two other solid waste problems in rural areas: open dumps and roadside litter. Their recommendations for these are, respectively, sanitary landfills and a twice-a-year clean-up operation.)

Both books underline the complexity of policy formulation for collecting abandoned vehicles and the importance of local variables in this nation-wide problem. These factors, as well as the need to monitor such developments as the changing materials composition of automobiles and the impact of these changes on disposal, demonstrate the necessity for continuing work on the problem of abandoned vehicles.

Michael B. Bever is Professor of Materials Science and Engineering, Emeritus and Senior Lecturer at M.I.T.; David C. Major is currently Visiting Scholar at the U.S. Army Corps of Engineers Institute for Water Resources. □

Up and Through the Organization

The Unconscious Conspiracy: Why Leaders Can't Lead
Warren Bennis
New York: Amacom/American Management Associations, 1976, ix + 177 pp.; $9.95

Reviewed by Lotte Bailyn

In this collection of essays, written between 1970 and 1976, Dr. Bennis discusses the constraints on leaders in today's complicated world. It is a book that contains much wisdom for many situations. It is also a very personal statement, based on the author's experiences as executive vice president of the State University of New York at Buffalo and as president of the University of Cincinnati. It reveals how a humane, liberal, and self-aware man reacted to the "irrational" challenges of the late 1960s. It vividly portrays what happened to Dr. Bennis' theories of leading and changing organizations when he tried to apply them under very trying circumstances.

"The experience," he reports, "has been painful." It transformed him from a liberal reformer into a "relentless gradualist." One empathizes with Dr. Bennis' poignant description of how his plans for reforming the university were controverted by the routine requirements of his job. And one senses the anguish of his conclusion that strategies for change based on participation and trust may backfire when people no longer share a common purpose.

Consensus, Community, Comity

Dr. Bennis' central point is that leadership must be distinguished from management. It is no longer possible to guide our institutions merely by managing them, however brilliantly. The Vietnam War, student uprisings, and Watergate — themes returned to over and over again — give ample evidence of the failure of attempts at management without leadership. Negotiations, participative decisionmaking both fail without mutual trust. And when consensus, community, and comity (to use Dr. Bennis' three C's) no longer exist, this crucial ingredient is absent. Some of the passion of these essays, in fact, is rooted in the anomaly that the liberal perspective on organizations is based on a fundamentally conservative model of change which cannot restructure institutions. At best, with the use of "available data and ideas in order to create *incremental* changes" (italics added), it may lead to "organizational renewal."

Recognizing that basic change may require edict instead of negotiation, Dr. Bennis remains a liberal optimist nonetheless. In his conclusion he invokes a new metaphor: leaders, he says, must be "social architects." They must understand the culture with which they are dealing before they start to build.

How can this be achieved? Dr. Bennis has no definitive answers, and promises none. His expressed goal is rather to pose the right questions. But he has ventured many suggestive nuggets, a number of which highlight important organizational issues.

One deals with the issue of succession to top organizational positions. As distinguished from a manager, Dr. Bennis finds that a leader must be a conceptualist and must be able to combine good ideas with an entrepreneurial instinct for implementation. At the same time he or she must deal with an unpredictable and turbulent environment, a set of external forces from which the organization is protected only by a "boundary . . . like Swiss cheese." No one can accomplish these tasks without some distance from the organization's daily concerns; without time to reflect; without being flexible and willing to take risks; without the possibility of error. Lower down the hierarchy, in contrast, hard work, attention to details, concern for the regularity of results, and adherence to standards are very important. There, risks must be avoided. This distinction implies that rising within an organization requires experiences, skills, and attitudes different from those required at the top. The characteristics we reward with promotion seem not to be the same as those we require of chief executives.

But in this logic there lies a dilemma, for it points to the value of recruiting for top positions from outside the organization according to different criteria from those used for lower managerial positions. It might require, therefore, a reassessment of promotion and succession policies, in order to choose the most effective leaders without allowing competent managers to be caught in a frustrating bind.

The Executive Constellation

To function successfully as a "social architect," a leader needs valid information. Because a single individual can no longer process all the information in a system, a leader must rely on others to select what is relevant. And it is in this process that bias may occur. And bias, even in favor of information that leaders want to know, always interferes with effective functioning.

How can leaders insure the validity of the information they receive? One strategy, according to Dr. Bennis, is the "executive constellation": a way of "multiplying executive power" through "temporary systems of assembling task forces for a particular assignment, then reassembling others for different ones." Another is the choice of key subordinates who will convey the "truth" to their bosses. They will only be able to do this, however, if they have another job to return to, so that they do not become dependent on retaining their assistantship; if they have a constituency of their own to which they are accountable; and if their assignments are temporary. All of these strategies imply a flexibility of positions not usually found in organizations. It is an important point because recent research has shown

the need for such multiple roles from the point of view of the employee as well.

How do leaders process information from the environment external to their organizations? In answering this question, Dr. Bennis highlights a particularly interesting set of roles required by his concept of leadership. These are the "social gatekeepers," the "variance sensors," the "scanners." They are roles at the margins of organizations. Only here can one find insiders with an outsider's perspective: people able to identify the discrepancies between what the organization is in fact doing and what it might be doing, who can identify issues in the external environment to which the organization must respond. Often they are roles most ably filled by "bad" employees: grumblers, employees not fully committed to their organizations or to their work. Recognition of the importance of these roles may therefore compel an organization to make creative use of employees who might otherwise be disenfranchised.

The concept of leadership laid out by Dr. Bennis in this book requires more fluid relations within an organization, and between the organization and its environment. It implies more heterogeneous criteria for effective performance, more different ways to accommodate individual competencies and interests, more movement of people between organizations. It implies, therefore, a shift in our accepted assumptions about organizational life. It is a shift that also fits with what we are learning about the needs of today's organizational employees. The organizational roles that people want and are able to fill most competently are much more various than we have previously assumed. They also vary over an employee's lifetime. The same person who is a marginal scanner at one point, may, at a different time and perhaps in another organization, be the ideal leader. And the competent line manager with long experience in a particular organization might well be, for a short time, a particularly effective staff assistant.

We must relinquish the notion that the only successful path through an organization is up. Today's employees, living in ever more various ways, require more options in order to perform effectively. And organizational tasks, Dr. Bennis has shown, have become differentiated enough to accommodate them, if only we do not let traditional assumptions and procedures stand in the way.

Lotte Bailyn is Associate Professor in the M.I.T. Sloan School of Management. □

Tidal Power in the Bay of Fundy

George F. D. Duff

Time and tide wait for no one. Their inevitability is one of the appealing features of the tides to those who would turn to them as a source of energy as supplies of increasingly costly fossil and nuclear fuels dwindle with the passage of time.

Since the oceans formed, their tides have alternately ebbed and flowed at shorelines in their diurnal wanderings. Centuries ago, ingenious Europeans harnessed the energy of tides to turn water wheels, converting the energy of moving water into the spinning motions of useful machines. Today several nations are examining the potential of tidal waters to spin turbines and generate electricity, following the lead of France and the Soviet Union, where practical tidal power conversion machinery was built in the 1960s. Tides, as it turns out, contain about 4×10^{12} watts of total power, an amount that is by coincidence within an order of magnitude of the world's present rate of electrical consumption.

The world's largest tides occur in the Bay of Fundy, which separates New Brunswick and Nova Scotia in eastern Canada. The head of the Bay, an extended ocean inlet about 200 miles long and 40 miles wide, sees an average tidal rise and fall of about 37 feet, and a phenomenal rise of 56 feet over the low-tide mark has been recorded there. Each cycle of the Fundy tide dissipates close to 5×10^8 kilowatt-hours of energy, a quantity nearly equal in magnitude to the consumption of the entire Canadian electrical network.

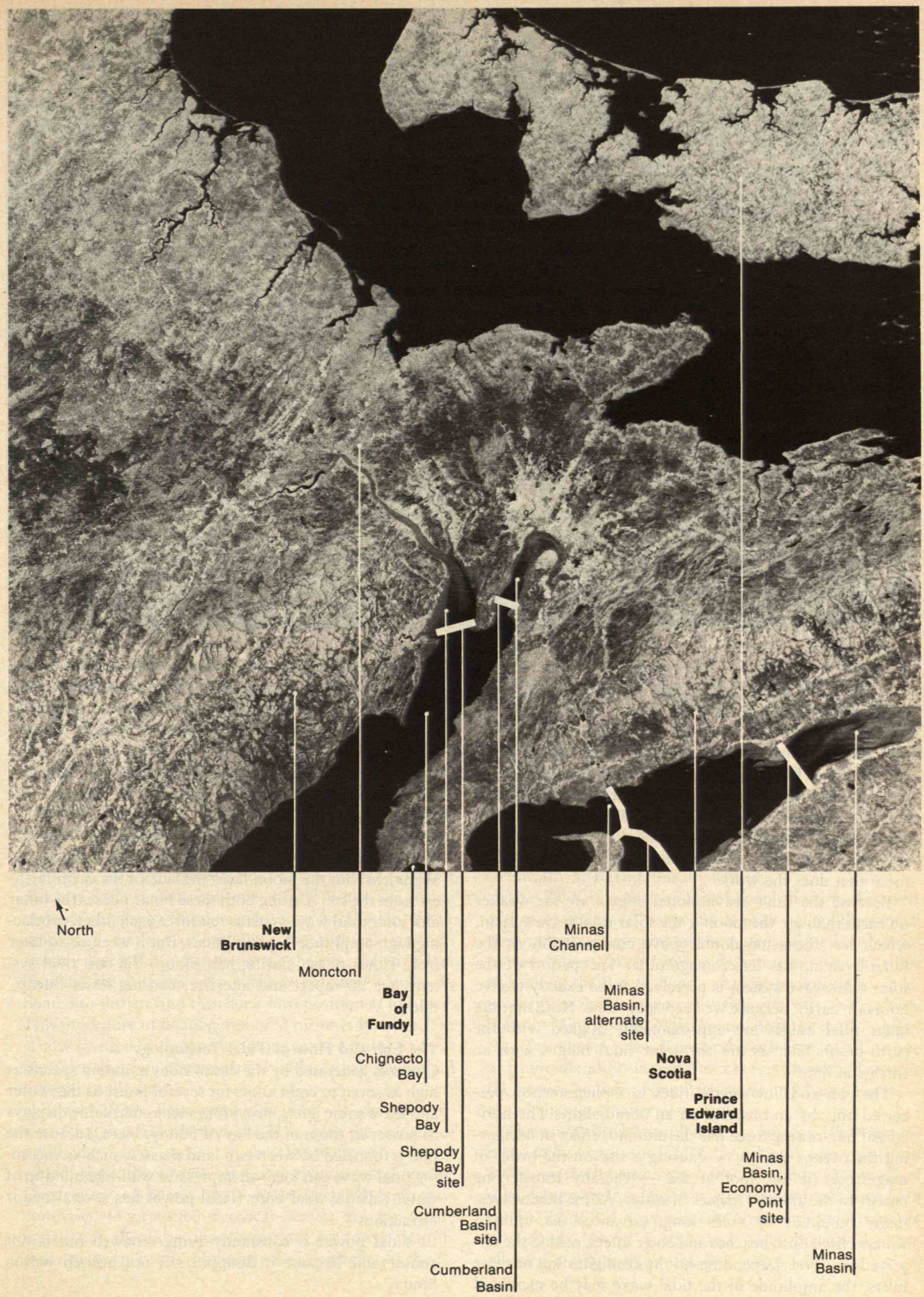
A plant harnessing some of this power could add to the practical experience already generated by the French and Soviet projects and might encourage other nations with appropriate coastlines to extract power from the tides. Cook Inlet in Alaska, the coastline of the English Channel and the Irish Sea, the Sea of Okhotsk off the coast of the Soviet Union, the coast of the Yellow Sea off Korea, and the inlets of the Kimberly Coast in Australia offer high tides and convenient sites for constructing tidal power conversion machinery.

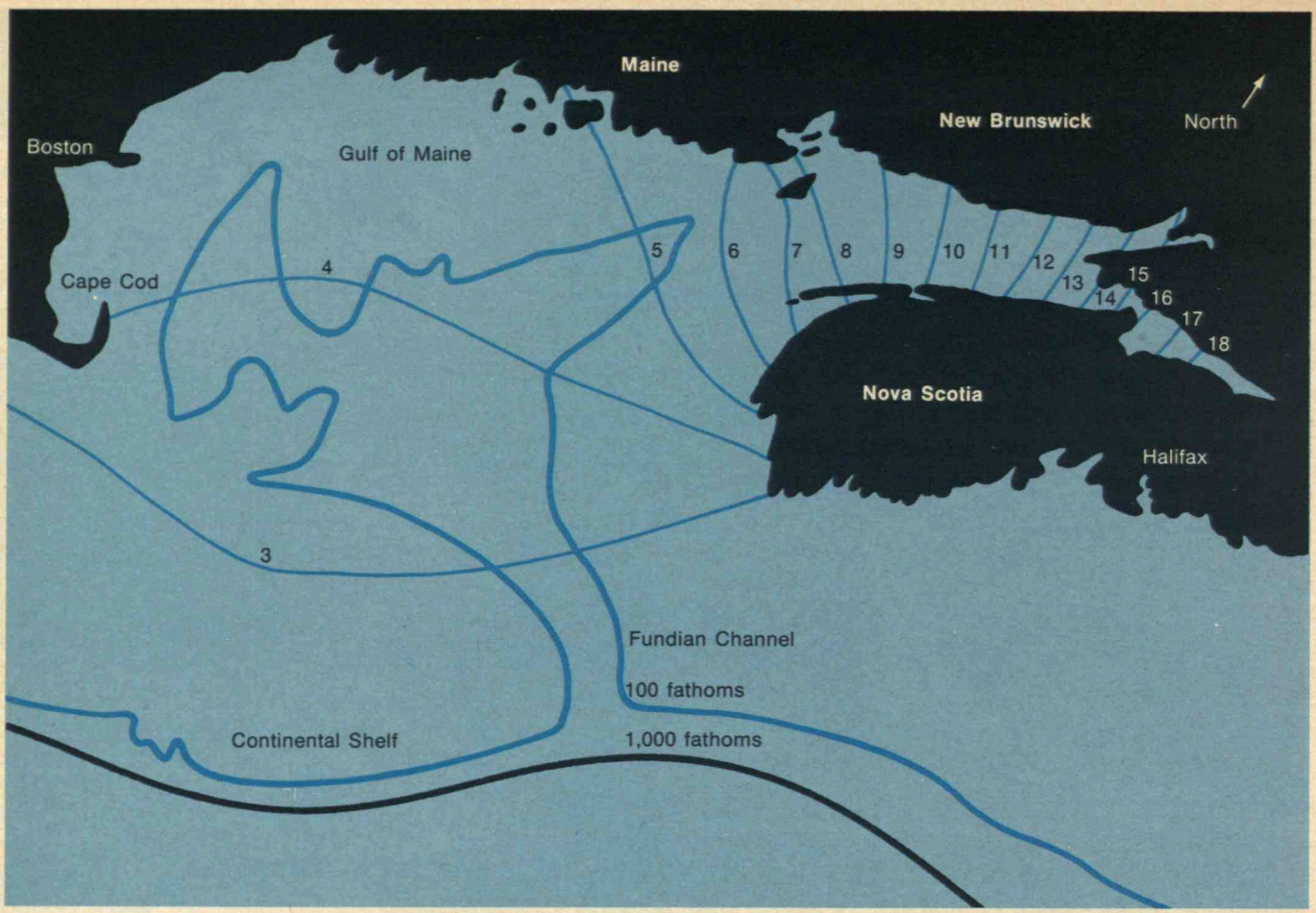
Why the Oceans Have Tides

The tides are moving masses of water, and by the laws of Newtonian physics must be subject to the influence of imbalanced forces. The tides are caused by spatial variation across the earth of the gravitational forces of the moon and sun. The lunar attraction pulls the oceans on the near side of earth toward itself most strongly, creating a tidal bulge or wave in the oceans. The moon also pulls the comparatively rigid earth away from the oceans on the far side, thus raising a double bulge of ocean waters that follows the moon as it orbits the earth. Because the earth rotates once every 24 solar hours, this double wave system is perceived on earth to have a period of twelve hours plus a correction of twenty-five minutes to account for the moon's simultaneous progress in its orbit.

The gravitational attraction between earth and moon is

The Canadian Tidal Power Review Board determined the four sites in this LANDSAT photograph of the Bay of Fundy to be the most amenable for locating tidal power conversion systems. The T.P.R.B. held that the Cumberland Basin site is the most attractive of the four in meeting cost and need criteria. Cumberland Basin is about ten miles long, excluding the tributaries at its head and the barrier at this site would cross the two-mile expanse of water from Peck's Point, New Brunswick, to Boss Point, Nova Scotia. Such a plant could be built by 1990. Not shown here, Annapolis Royal, Nova Scotia, has been selected by the Nova Scotia Tidal Power Corporation to be the location of a turbine test installation. (Photo: N.O.A.A.)


North
New Brunswick
Moncton
Bay of Fundy
Chignecto Bay
Shepody Bay
Shepody Bay site
Cumberland Basin site
Cumberland Basin
Minas Channel
Minas Basin, alternate site
Nova Scotia
Prince Edward Island
Minas Basin, Economy Point site
Minas Basin



The thin blue lines indicate tidal amplitudes in feet. The heavier blue line is the 100-fathom contour, which outlines the Fundian Channel. The black line represents the 1,000-fathom contour at the edge of the continental shelf.

not the largest force; that of the sun is larger. Only when the difference between forces at the surface and center of earth is taken does the moon's effect exceed the sun's. The vertical component of these differential forces is 10^5 times smaller than the gravitational attraction of the earth for its oceans, so the horizontal component is actually the force that does the work.

Because the sun's gravitational effects are far weaker on earth than are the moon's, the solar tidal wave system, which has the same double-wave configuration as the lunar system, has lesser magnitude. The period of the solar tidal wave system is perceived to be exactly twelve hours on earth, because we keep solar time. Note that the lunar tidal bulges are approximately aligned with the earth-moon line, as are the solar tidal bulges with an earth-sun line.

The ebb and flow of the tides is a phenomenon perceived only by an observer on an ocean shore. The horizontal tide-raising force has the ultimate effect of oscillating the oceans slightly — causing a rise on the order of magnitude of one foot at sea — thereby transferring energy to the affected masses of water. As the tidal waves, many hundreds of miles long, advance, the uplifted waters climb onto beaches and enter inlets, raising the observed sea level. Depending on the configuration of these inlets, the amplitude of the tidal wave may be increased many times. (The term "tidal wave" should not be confused with the tsunami seismic phenomenon sometimes incorrectly called a tidal wave.) As the earth continues to rotate, the areas flooded by high tides reemerge, and the water drains back to its lowest level as the tide ebbs. The motion of the flowing and ebbing tides represents the vast levels of energy already cited, which dissipates over periods of several days.

At new moon the moon and sun are aligned on the side of the earth nearest the sun; at full moon they are also in alignment, but the moon faces the side of the earth farthest from the sun. During both these lunar phases the lunar and solar tidal wave systems reinforce each other, producing high amplitude "spring" tides. But a week or so later from either phase, during half moon, the two tidal systems are 90° apart and interfere, causing lesser "neap" tides.

The Ebb and Flow of Tidal Technology

Currents generated by the ocean tides maintain speeds as high as seven to eight knots for several hours as they enter and leave some inlets, providing such remarkable displays of power as those in the Bay of Fundy. Here, because the tide is funneled between two land masses, such an incoming tidal wave can form an impressive wall-like buildup of water called a tidal bore. Tidal power has several major attractions:

☐ Tidal power is constantly being renewed but is not conservable because it disappears if not utilized within hours.

☐ Tides are an indigenous resource that if exploited would conserve dwindling fossil fuel supplies and would reduce problems of foreign exchange inherent in the importation of oil.
☐ Tidal power plants can have extended lifetimes on the order of 100 years, with extremely low and stable future operating costs.
☐ Tidal power is nonpolluting and has minimal environmental side effects.

Methods of extracting useful mechanical motion from rapid movements of water are centuries old. From the 12th century until 1956, tidal energy turned water wheels in a mill on the Deben River at Woodstock in Suffolk, England. The mill is now an historic monument.

In more recent years, tidal energy has been successfully harnessed in several nations to generate electricity. In these nations and elsewhere tidal power potential has been studied in great detail.

Since 1966 the modern 240-megawatt-capacity tidal power plant on the Rance estuary in Brittany, France, has supplied electricity reliably to the French electric power grid. When spun by rushing tide water the turbines in the Rance installation activate electrical generators. Powered by electricity from the grid, the same turbines also pump ocean water into the Rance estuary during intervals near high and low tide. This pumping augments overall energy recovery by producing higher "heads" of water and increasing the period of productive gravity-induced flow through the turbines during the following part of the tidal cycle. Twenty-four of these beautifully designed 10-megawatt-capacity turbine pump-generators are installed in bulb-like casings, which are mounted in passageways in a half-mile-long dike spanning the estuary.

In 1967, Soviet engineers built a two-turbine tidal test plant at Kislaya Guba, an inlet of the White Sea, using turbines similar to those in the Rance installation. Their innovative method of installing the turbines was extremely successful. After preparing the site, the engineers installed the turbines in a concrete caisson, which was floated to the site and then sunk into position at low tide. This procedure of floating mounted turbines into position is now favored by designers in some other nations, including Canada, that contemplate building their own tidal power installations.

In the 1930s Passamaquoddy Bay, on the Atlantic Coast joining Canada and the U.S., was the subject of preliminary tidal power works that were never completed; some dikes were built and abandoned. A recent Department of Energy study estimates fairly high costs compared to projected electrical output for any future installation there, because these tides are lower than in more promising sites. However, the geography of the islands and channels around Passamaquoddy Bay may be advantageous for storing tidal water in two huge basins. Such a double-basin system would enhance the extraction of power by extending the period of usefully ebbing tidal water. More may yet be heard of Passamaquoddy.

While Great Britain will almost certainly build some sort of system to extract power from ocean movements, for the moment it is not clear whether the system will be based on tidal power or wave power. A stiff competition between the two technologies for government interest and support exists in British energy circles, with strong and weak arguments for both sides. Tidal power certainly has great potential: calculations indicate that several-thousand-megawatt blocks of power could be obtained from a tidal power barrage built across the turning point in the Severn estuary, between England and Wales. But proponents of wave-power conversion point out that their systems can be much smaller than tidal power schemes and do not require the effort and expense necessary to dam entire bays and estuaries. The tidal power supporters point out that the efficiency of wave power installations is unpredictable, suffering when wave patterns are irregular and the weather is unfavorable.

An Optimistic Reassessment of Fundy Tidal Power

A joint Federal/Provincial Tidal Power Review Board (T.P.R.B.) concluded last year that electricity produced by harnessing Fundy tidal power can now compete economically with electricity produced by other means, and would in fact displace the production of electricity by fossil-fueled generating plants. The review suggested that the integration of tidal power into the planned generation system of the Canadian Maritime provinces is both technically and economically feasible.

The T.P.R.B.'s positive set of conclusions is the latest and most definitive in a series of joint Federal/Provincial government assessments of the potential for Fundy tidal power conversion. A 1969 study had recommended three sites along the Bay of Fundy as most promising for tidal powerplant development. The first site was at Economy Point in Minas Basin, Nova Scotia, near the world's highest semi-diurnal tides. Tides at the other two sites — one at Cumberland Basin and the other at Shepody Bay near the border between New Brunswick and Nova Scotia — are of slightly smaller magnitude.

There was little incentive to act on the 1969 recommendations until the O.P.E.C. oil embargo struck in 1973, markedly improving the economic prospects of tidal power, and leading to new studies that culminated in the 1977 T.P.R.B. reassessment. Already the governments of Canada, Nova Scotia, and New Brunswick have planned a $30 million detailed design study for a tidal

power plant in Cumberland Basin. It is expected that this design study will be the first major task of the newly formed Maritime Energy Corp., which will oversee the development of the electrical system in Nova Scotia, New Brunswick, and Prince Edward Island.

The 1977 reassessment, while positive overall, was unusually complex and pointed out several areas needing further study. It included detailed discussions of technical problems related to harnessing the tides at the Cumberland Basin as well as calculations of the smooth integration of tide-generated electricity into the electrical system of the three provinces. The research topics included the following:

- ☐ determining the effect of a tidal power conversion plant on the magnitude of the tides in the Bay of Fundy;
- ☐ estimating the cost of the project and its probable economic impact;
- ☐ designing and building the installation;
- ☐ timing and absorbing the entry and exit of large blocks of electrical power to and from the Maritime provincial system; and
- ☐ forecasting and assessing environmental effects that could result from the installation of the tidal power conversion system.

The Tidal Resonance Problem

The Bay of Fundy has an overall resonant frequency, similar to the acoustic resonance of an organ pipe. This resonance is considered to be essential to the production of Fundy's very high tidal amplitudes. Just as changing the dimensions of an organ pipe "detunes" it so that it no longer produces high amplitude vibrations, building a tidal barrier would shorten the length of the Bay and diminish its natural resonance. If this upset were to seriously detune the Bay and reduce tidal amplitude significantly, the very existence of a tidal power conversion plant might paradoxically reduce its own effectiveness.

Both the 1969 and 1977 T.P.R.B. studies investigated the likelihood of such detuning effects. Numerical modeling techniques were used primarily to describe the rise and topography of the floor of the Bay, and the convergence of its shorelines, which together act to increase tidal wave amplitude greatly.

The amplitude of a tidal wave in deep ocean is rather modest — on the order of one foot. But as such a wave enters and advances up the Bay, it is increased by the rising ocean bottom and funneled by the converging shorelines. In the upper reaches the wave is steepened by the effect of the rising bottom, and then progresses up the rivers as a tidal bore, visually distinct from the relatively quiescent waters already there. The length of the Bay and velocity of the tidal wave are such that the rapid flow and subsequent ebb of the tide are complete just prior to the beginning of the next tidal flow.

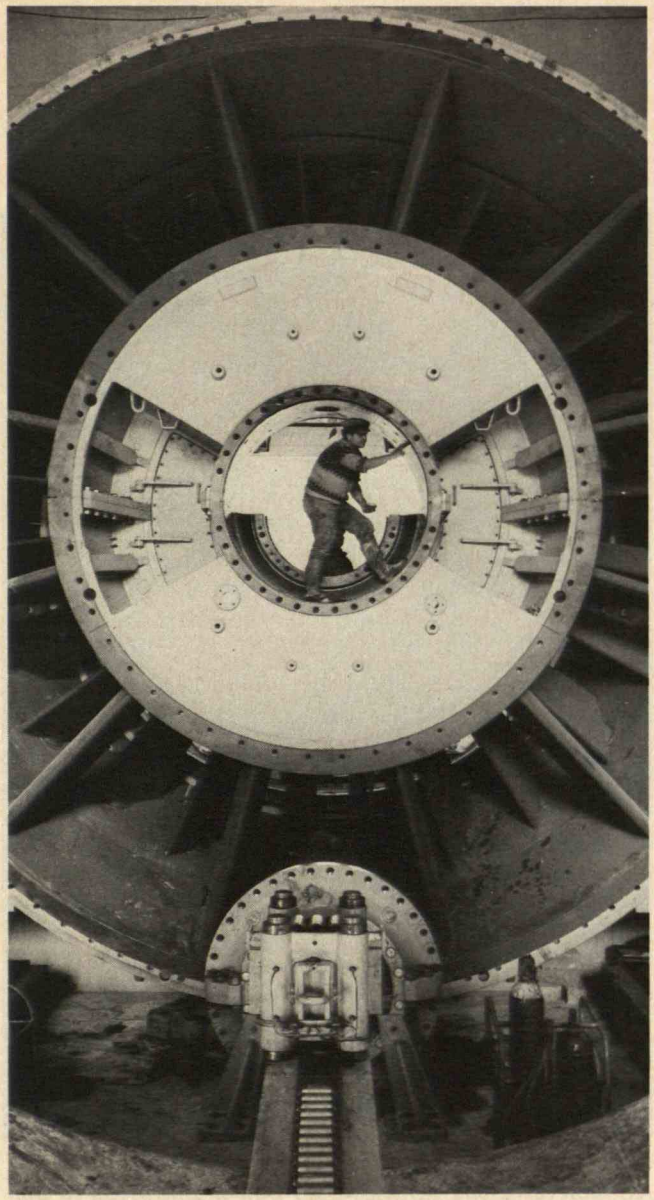
Should the length of the Bay be changed so that an incoming tidal flow were faced with an ebbing tide partway up the Bay, its velocity would be reduced, and so would its rise in amplitude. A tidal wave following directly on the heels of a departing ebb tide would have the best chance of maintaining a high amplitude and producing a large tide at the head of the Bay. Resonant high tides will be most likely to occur if the natural period is about 12 hours, 25 minutes.

The T.P.R.B. considered that a tidal barrier constructed at a point well below the head of the bay will shorten its natural period. The decrease in period will throw off the timing, or resonance, of the ingoing and outgoing tides, leading to reduced tidal amplitude, and affecting tidal power prospects. For example, it was calculated that barriers at the giant sites near the tip of Cape Chignecto where Fundy divides would reduce the amplitudes there by one-third, rendering these sites completely unsuitable for tidal power conversion. The T.P.R.B. recommended that the sites of tidal barriers should be located fairly close to the head of a bay to minimize the likelihood of such decreases.

An early calculation of the natural period of the Bay of Fundy itself produced a value of about 9 hours — much smaller than actual field observations. This low value suggested that the observed resonance involved a larger sea area, which was subsequently found to include both the Bay of Fundy and also the Gulf of Maine, limited on the southwest by the shallows south of Cape Cod and on the northeast by the banks extending seaward from Nova Scotia. The shallow fishing ground of Georges Bank occludes much of the perceived sea boundary so that nearly all the tidal wave energy enters through the narrow Fundian Channel, a submarine valley 150 fathoms deep. (*see the chart on p. 36*)

By comparing amplitudes of the principal lunar, principal solar, and lunar ecliptic tidal harmonics within the Bay of Fundy/Gulf of Maine system with corresponding amplitudes in the outer North Atlantic Ocean, C.J.R. Garrett showed that the Fundy/Maine system behaved as if its natural period was approximately 13 hours — about one hour longer than the optimal 12-hour period. This finding gave the first evidence of the possibility that a tidal barrier in the longer Minas Basin arm of the Bay might *increase* the resonance and actually *raise* tidal amplitudes by reducing the Bay's natural period slightly.

Detailed calculations by D. Greenberg have shown that a tidal barrier at Economy Point in Minas Basin can be expected to increase tidal amplitudes slightly, but at other points in the system rather than at the barrier site itself.



This bulb turbine in the Rance tidal plant in France is designed to resist the corrosion and fouling of its marine environment, and to be conveniently maintained. It is fashioned from stainless steel and aluminum-bronze alloys, which are further protected with vinyl and epoxy paints, and cadmium plating with a bichromate protective coating. Once in the ocean a cathodic protection system counters electrolytic corrosion from seawater by distributing 100 milliamperes of negative polarity direct current electricity at 800 millivolts potential over protected submerged parts. A scheduled replacement regimen calls for renewing some major working parts — bearings and rotor and stator windings — every 15 years, while transformer windings need not be changed for 40 years. Repairs can be made to the stator windings in a working "pit" by removing the rotor from the stator; a major seal can be dismantled without draining seawater from the duct; individual turbine blades ("runners") are accessible for replacement by removing the top part of the "throat ring" on the seaward side, shown, of the duct. (Photo: M. Desjardins — Photothèque EDF)

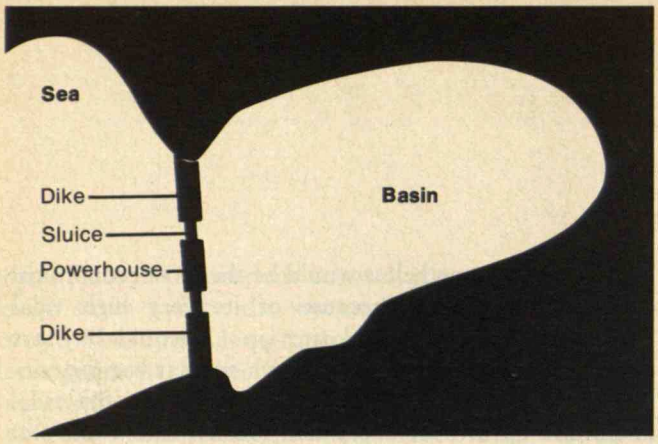
This large site nonetheless would be the most economical of the possible sites because of its very high tidal amplitudes. Two potential sites in Cobequid Bay are probably below the resonant length so that barrier construction at either location would diminish the tidal amplitude up to 6 or 7 per cent locally, but would not cause any appreciable increase elsewhere.

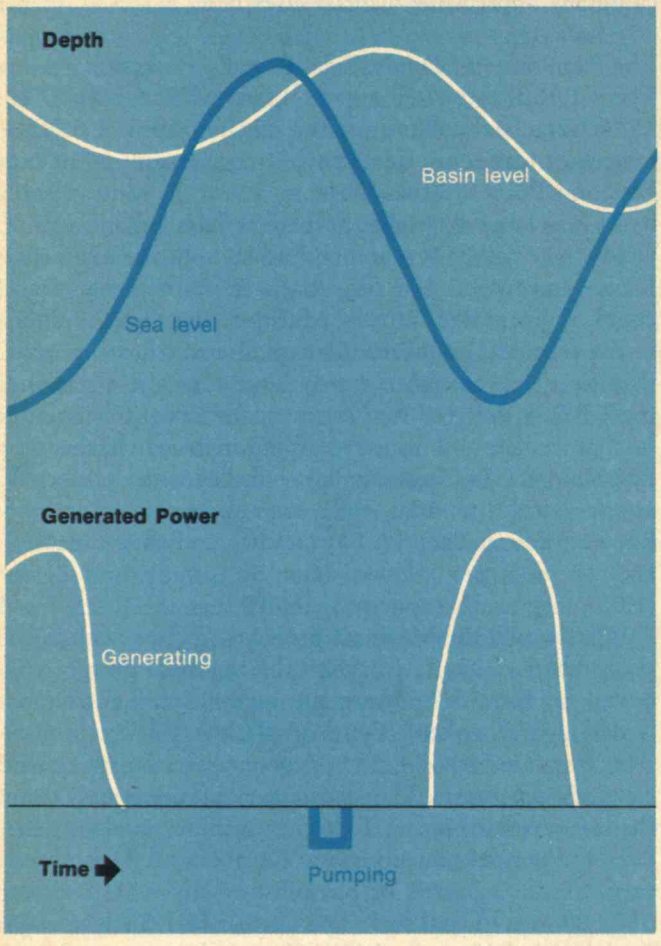
The Economics of Fundy Tidal Power Conversion

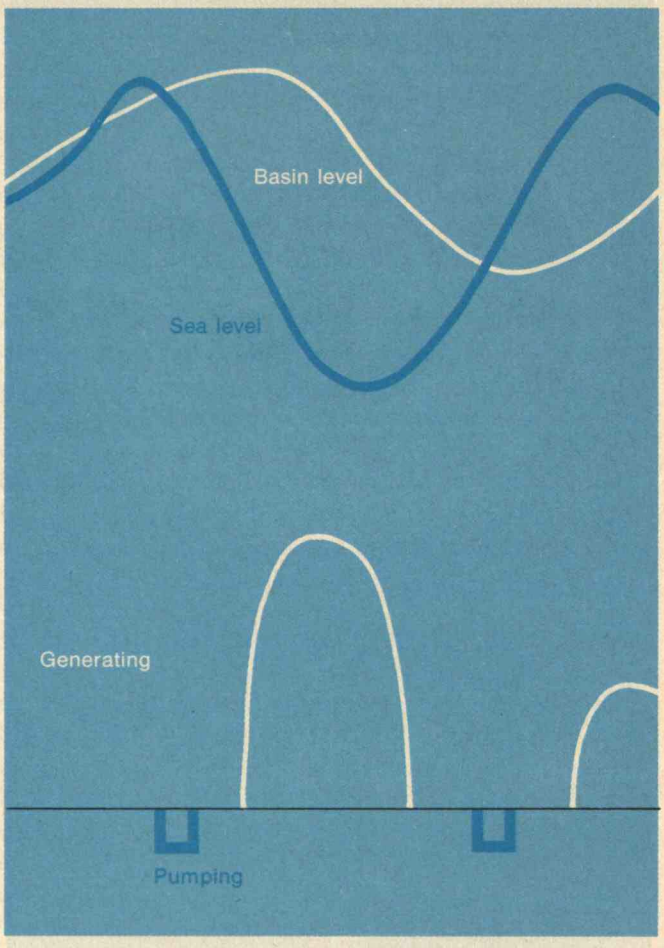
The T.P.R.B. estimated a capital cost of $3.6 billion (in 1976 Canadian dollars) for the installation of a 3,800-megawatt capacity tidal power conversion plant at Economy Point in Minas Basin — about the same capacity as four large nuclear powerplants. Such a plant would yield at-site power at a unit cost of 18 mills per kilowatt-hour. However, 3,800 megawatts is more power than could be integrated into the Maritime Provinces' system in the foreseeable future; the capital cost burden would therefore also be unnecessarily large. For these reasons the T.P.R.B. deferred further consideration of this potent tidal power site and turned its attention instead to the two favorable sites in Chignecto Bay. For these sites, projected at-site costs for tidal electricity were 30 mills per kilowatt-hour in Shepody Bay (1,550 megawatts capacity) and 22 mills per kilowatt-hour at Cumberland Basin (1,085 megawatts capacity).

What would the Maritime provinces get for such huge investments of capital? Beyond the electrical power generated by the tidal powerplant, significant fuel savings would also be realized. For example, the Maritime provinces now use fuel oil-fired boilers to power most of their electrical generators. The costs of fuel oil rose steeply over the last several years. A T.P.R.B. computer model calculated that a tidal power plant at Cumberland Basin could save 3 million barrels of fuel oil annually — as well as 380,000 tons of coal and some nuclear fuel. Such savings over a period of years might well exceed the costs of constructing the tidal power plant. For a 30-year period, the cost/benefit ratio for a Cumberland Basin plant (and also for the larger Economy Point site) was estimated at 1:1.2. In arriving at this estimate, the T.P.R.B. used a "real" annual interest rate of 5.5 per cent. In their calculation this rate was adjusted to remove the effects of inflation, but included realistic risk and borrowing costs. On the basis of these cost-benefit projections the T.P.R.B. selected the Cumberland Basin site for a tidal power plant estimated to cost $1.2 billion, and the three concerned governments accepted the recommendation.

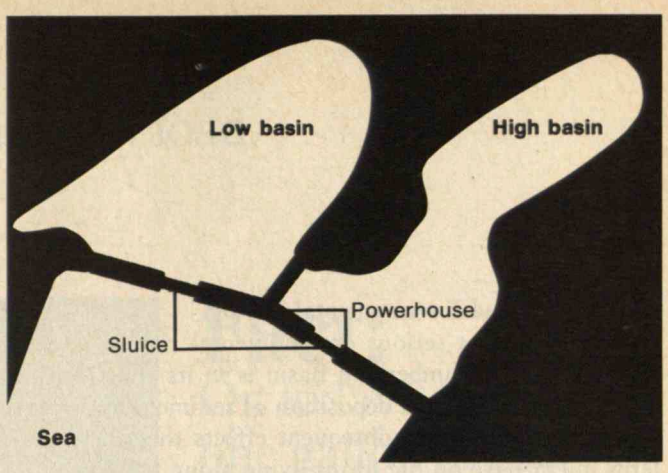
Barring unforeseen developments, a detailed design for the Cumberland Basin plant may be completed in three years. A final decision on construction would then be made. Construction could involve three methods:







On the left is shown the result of "single effect" power generation in a tidal power station that utilizes one basin for storing tidal water. At high tide a period of pumping sea water into the basin draws electrical energy from the local power grid, but produces a greater final net energy yield.
On the right is shown the result of "double effect" power generation, which has two pumping intervals, one at high tide and one at low tide. Reversible pump-turbine units are required in both single effect and double effect power generation schemes, if pumping is used.



☐ the Soviet method of floating in bulb turbines mounted in caissons, referred to as "construction in the wet" in the construction industry;
☐ building power houses and sluices behind dewatered cofferdams — "construction in the dry behind cofferdams";
☐ building the power houses and sluices underground in a convenient headland and later removing natural rock plugs to open the passageways for the water — "construction in the dry behind natural rock plugs."

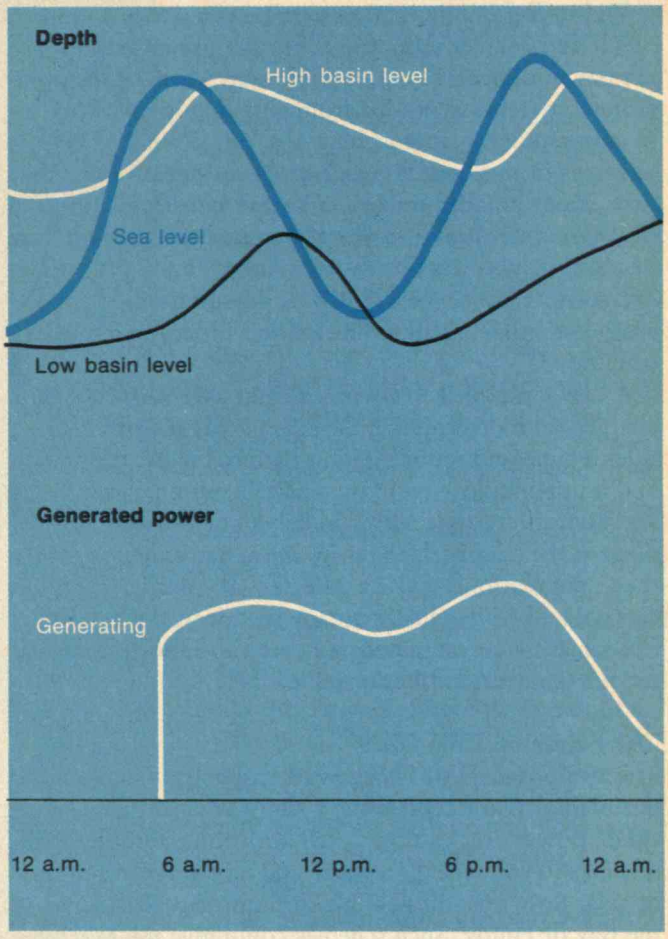
About 10 years would be required to complete the construction of the plant, so that it could be expected to be operational by 1990.

Design and Operation of the Proposed Cumberland Basin Tidal Plant

The design now proposed for the Cumberland Basin plant uses a "single effect" tidal barrier, and a single basin to moderate the flow of tidal water. Single effect generation involves filling the enclosed basin using additional pumping, only at the end of ebb tide. The water would enter through 24 large sluice gates as the tide comes in and would exit through 37 7.5-meter diameter turbines, each with a rated generating capacity of 31 megawatts. The filling and emptying operations would be timed to make the most electricity from each tidal cycle.

Fitting Tidal Power into the Provincial Electrical System

The problem of scheduling or retiming the periodic blocks of electrical power from the Cumberland plant and of absorbing it into the Maritime energy system involves many complexities. On some days the timing of the block of tidal electricity would fit in neatly with the daily demand peak. But the moon advances 50 minutes in its orbit each day, so that a few days later the power would be produced at the wrong time. The size of the tidal power block would grow gradually from neap to spring tides — a period of one week — and then decline. The T.P.R.B. developed a computerized model to study the integration of the tidal blocks of power and found that over 80 per cent of the Cumberland Basin output could be directly absorbed in the Maritime Province system. The remaining energy could be stored for later use in the Maritimes, or exported to the New England Power Pool.



The twenty-four hour cycle shown for this double-basin tidal plant scheme calls for power at 6 a.m. after a slack night period. The center powerhouse then generates steadily until midnight. Turbines on the seaward dikes of the high and low basins generate electricity — and alternately pump seawater into the basins if energy is available. The percise pattern of electrical output delivered depends on the phase of the cycle and the height of the tide on that day. A power station of this design can use any available energy for pumping, thus increasing the store of energy for generation and delivery later the same day.

Geophysical and Environmental Factors

Perhaps the most serious environmental risk of a tidal power plant at Cumberland Basin is in its effect on the erosion, transport, and deposition of sediment in the Bay of Fundy, and of the subsequent effects these new patterns might have on life forms living along the Bay.

The strong Fundy tidal currents entrain vast tonnages of silt and coarser sediment about the upper branches of the Bay and especially in Minas Basin. Much of this fine-grained material is eroded from cliffs along the shoreline by the gradually encroaching sea. Sea level is creeping upwards in this area at a rate of about one foot per century. Much smaller-scale river barrier construction in the Maritime provinces has already caused unforeseen river narrowing and sandbank formation, and with these examples at hand, the T.P.R.B. is pursuing the continued study and modeling of sedimentation processes in the Bay of Fundy.

A newly established environmental assessment panel is charged with determining the effects that such changes in tidal regime and sedimentation patterns will have on fish and mudbank flora and fauna. While extreme changes in sedimentation patterns are unlikely to be caused by a tidal plant at the Cumberland Basin, the actual extent to which these populations will be affected at specific localities cannot yet be predicted with any certainty. Overall limits of change can be estimated more reliably, and are smallest for the Cumberland Basin site itself.

The Future of Tidal Power

The proposed 1,085-megawatt capacity Cumberland Basin tidal plant represents a step forward in scale for tidal power technology. In addition, double-basin schemes to enhance the storage and facilitate the retiming of tidal flow are still possible in both upper branches of the Bay of Fundy. Such schemes could give the Maritime provinces an option of choosing among tidal, fossil-fuel, and nuclear power that does not yet appear at this early planning stage.

The potential of tidal power conversion, while perhaps less than that of solar, wind, and hydro-power resources, still could become a substantial natural supplement to the economic use of renewable energy. Very full development of tidal energy conversion plants in the Bay of Fundy could possibly harness some 10 to 15 per cent of the available natural tidal energy. On a worldwide scale, many less concentrated sites could capture and use perhaps 3 per cent of the planet's tidal power, if the economics continue favorably.

Further Readings

"Final Report on Tidal Power Study for U.S. Energy Research and Development Agency," U.S. Department of Energy contract number EX-76-C-01-2293, Stone and Webster Engineering Corp., Boston, March, 1977.

Garrett, Christopher J. R., "Tidal Resonance in the Bay of Fundy and Gulf of Maine," *Nature,* Vol. 238 (1972), pp. 441-443.

Garrett, Christopher J. R. and David Greenberg, "Predicting Changes in Tidal Regime: The Open Boundary Problem," *Journal of Physical Oceanography,* Vol. 7 (March, 1977), pp. 171-181.

Greenberg, David, "Mathematical Studies of Tidal Behaviour in the Bay of Fundy," PhD Thesis, University of Liverpool, 1975.

"Reassessment of Fundy Tidal Power," Canadian Tidal Power Review Board, Dept. of Energy, Mines, and Resources, Ottawa, 1977, 57 pp.

Revue Francaise de l'Energie, Sept.-Oct. 1966 (special issue on the Rance tidal power plant).

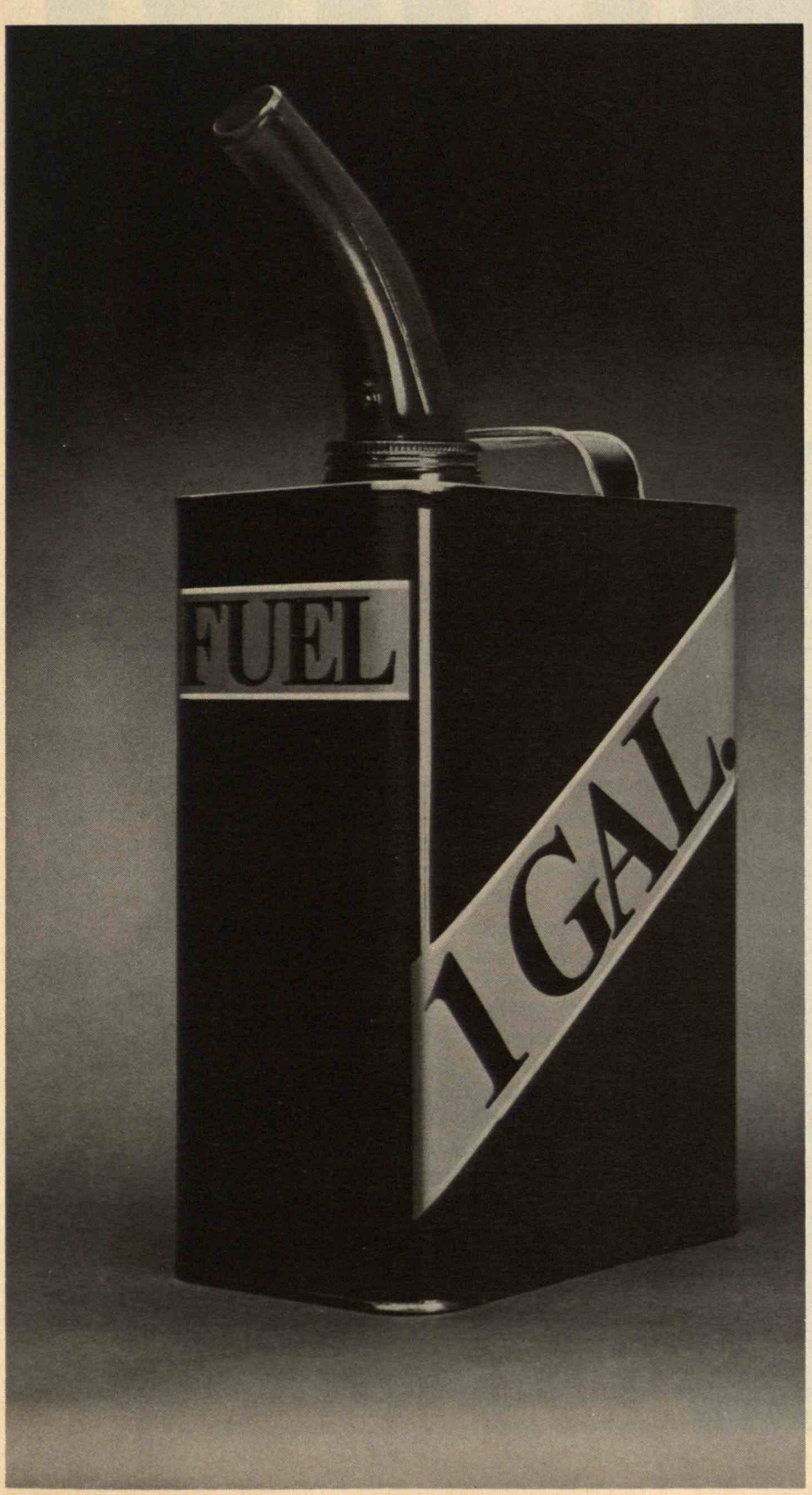
Rowsell, K. A., "Civil Engineering Design," *Fundy Tidal Power,* Acadia University Press, 1977.

Tidal Power, T.J. Gray and O. K. Gashus, eds., Plenum Press, 1972.

George F. D. Duff is Professor of Mathematics at the University of Toronto, and taught mathematics at M.I.T. from 1951 to 1952. He received his Ph.D. in mathematics from Princeton University in 1951, specializing in research into partial differential equations and their applications. He is also Editor-in-Chief of the *Canadian Journal of Mathematics*. Tidal power has been a concern of his for about 10 years.

Myth:

It takes a lot of fuel to move a heavy load.



Fact:

On today's railroads, one gallon of fuel moves a ton of freight 280 miles.

Most automobiles made in Detroit can go about 100 miles to the gallon—if they move by railroad. The same goes for most other goods that move by rail. Today, railroads use less than one-third as much fuel as trucks, on the average, to move big loads.

And railroads are working to save even more fuel in the future—with entire trains of grain or coal that require less energy than either barges or pipelines, with new space-age technology, with improved operating practices.

Piggybacking—the movement of truck trailers and containers on railroad flatcars—is the fastest growing part of the railroad business. It not only saves fuel, it reduces traffic congestion and improves highway safety by taking more than 2 million truckloads off the roads each year.

The Department of Transportation expects the nation's freight load to double by the year 2000 and the railroads' share to grow even faster. One important reason for this is that the existing rail system already has the capacity to handle many more trains. Another is the railroads' proven fuel efficiency.

Last year the railroads spent a record $9 billion for track and equipment improvements that will allow them to handle more freight with greater efficiency than ever before—saving both fuel and money.

For more facts about today's surprising railroads, write to: "FACTS," Dept. TF-2, Association of American Railroads, American Railroads Building, Washington, D.C. 20036.

Surprise:

We've been working on the railroad.

Photo: Cary Wolinsky, Stock, Boston

Technology for Human Rehabilitation

Robert W. Mann

Sophisticated applications of modern technology are beginning to open the cocoons which enclose those who are handicapped by disabling sensory or physical loss.

Disease, trauma, and congenital defects leave many humans permanently disabled. Current estimates of the number of physically handicapped in the U.S. range between 6 and 28 million persons, the uncertainty being the result of inadequate statistics and the use of many different definitions. All existing studies deplore the inadequacy of national demographic data on disablement; the universal conviction is that the cited numbers, although large, are probably understated. A useful working hypothesis for developed countries, well documented in Sweden, is that 12 per cent of the population suffers handicapping conditions of some kind — not including mental conditions.

MIT '79

Articles

Departments

Freshmen: Bright, Serious, and Conservative

Meet ten members of the M.I.T. Class of 1982. Without exception you'll meet bright young people, attracted to M.I.T. by its educational quality. And you'll find that most of them are politically conservative, worried about energy, taxes, and inflation far more than such social issues as poverty and corruption.

Of the 1,070 freshmen, just under 900 were in the top tenth of their high school classes. Nearly 550 of them scored between 750 and 800 (the highest possible) on the Mathematics Level II Achievement Test of the College Entrance Examination Board, and just under 500 scored in the same range on C.E.E.B.'s Mathematics Aptitude Test.

The Admissions Office offered membership in the Class to over 1,800 high school seniors. The 1,058 who elected M.I.T. represents a "yield" of 58.3 per cent, the highest since 1970, up 3 per cent from 1977.

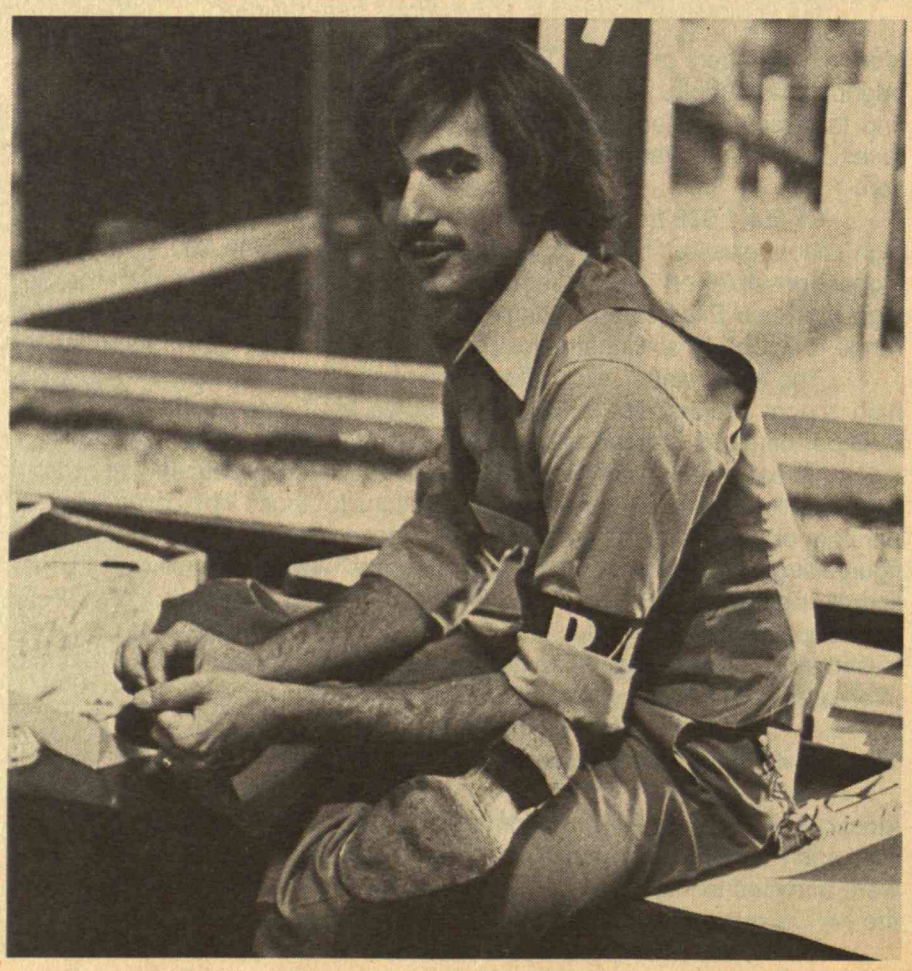
Questionnaires tell the Admissions Office that "educational quality" and "location" were the primary considerations for those who came, while 19 per cent of those who did not come said "money" was the main reason. The figures suggest that most of the "did-not-comes" were prospective science or liberal arts majors; "M.I.T. continues to do best with engineers," says Peter H. Richardson, '48, Director of Admissions. Indeed, 46 per cent of all the freshmen said they expected to major in engineering, and the "yield" of those interested in engineering was 70 per cent.

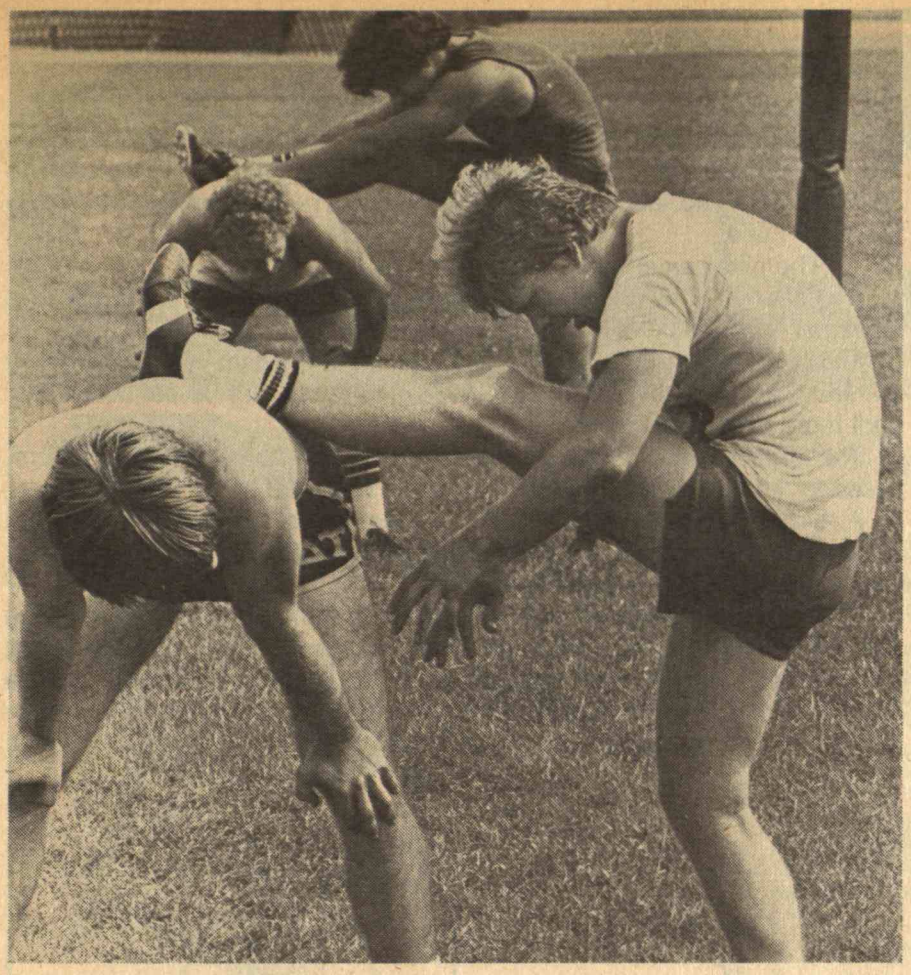
Where the Others Went, and Why

Most of M.I.T.'s competition is from other Ivy League schools, as usual. Harvard and Princeton between them took over 25 per cent of the students who were admitted to M.I.T. but did not come. Our top 12 competitors included all the Ivy League schools and Caltech, Stanford, Rensselaer, and Rice.

M.I.T.'s "yield" varies with financial need. Of applicants whose need

Gordon R. Haff, '79, prowled with his camera during this year's orientation week and pages A1-A3 are a small part of the result.





was less than $2,500 (they were eligible for loans but not scholarships) the "yield" was 53 per cent. For those whose need was $2,500 to $5,000, the "yield" was 62 per cent, and for students with need greater than $5,000 (they would have been offered scholarships of $2,500) the yield was 67 per cent.

Mr. Richardson watches these figures closely. "The critical area," he explains, "is the one in which M.I.T. is offering loans while our competition is making scholarship grants; these are students with need between $1,000 and $2,500. Here M.I.T.'s 'yield' is 52 per cent — a figure which is within the 'noise level' and does not indicate a significant deviation from 1977."

They Like the World the Way It Is

After looking at answers to questions asked of freshmen by students in his Public Policy Program, Professor Walter D. Burnham of the Political Science Department concludes that the Class of 1978 is politically conservative — "on the whole pretty satisfied with the existing order of things."

Some 70 per cent favored "a fixed limit" on government spending, and 58 per cent said they like California's Proposition 13 approach. Two-thirds are advocates of nuclear power, and only 10 per cent want to halt nuclear construction. Energy is rated as the country's most pressing problem by 32 per cent of the class, inflation by 26 per cent, poverty by only 6 per cent.

A Record Alumni Fund Reaches for $5 Million

A total of $4,969,076 — the highest in history — came to M.I.T. through the 1978 Alumni Fund, ending July 1. The previous record was $4,851,160, to the 1977 Fund.

The gifts came from a near-record 20,800 alumni.

Other 1978 records cited by Thomas H. Farquhar, '60, in his report as Chairman of the Alumni Fund Board:

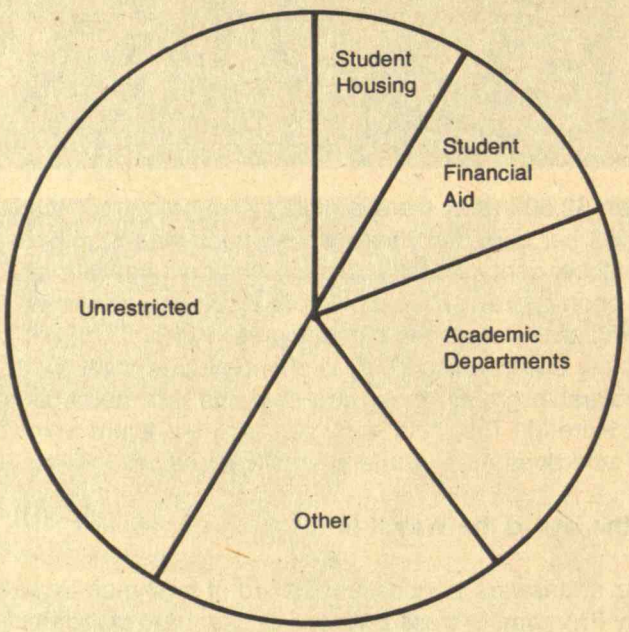
☐ The highest participation for any class during the final year of a reunion gift effort, achieved by the Class of 1953. The figure was 59 per cent, 5 per cent more than ever before.

☐ The largest total of corporate matching gifts in history — $417,802, compared to the best previous record (1977) of $294,499.

☐ A record 24 per cent participation by members of the Class of 1978 in a Senior Class Gift. (The funds are designated for improvements in the lobby of the Rogers Building — Building 7.)

Of the total giving, $666,734 qualified for matching from the challenge fund. That fund matched, dollar for dollar, increases of $25 to $1,000 in any individual's giving over the previous year — and *all* gifts from members of the Classes of 1973 through 1977. Participation in the Fund by those classes was sharply increased.

Almost half of the $4.969 million given to the 1978 Alumni Fund was unrestricted as to use. Just over $1 million of the giving (21 per cent) was for academic departments, $391,000 (8 per cent) was for student financial aid, $211,000 (4 per cent) was for student housing, and the remaining $969,000 was designated for other purposes.



M.I.T. INSIGNIA

A GOOD WAY TO REMEMBER

M.I.T. CHAIR. A traditional favorite made of selected northern hardwoods and finished in satiny black with gold trim and gold M.I.T. crest. In all black or black with cherry arms. each **95.00**

M.I.T. CHAIR CUSHION. Tough Duraleather cushion in deep red with grey piping and 2" thick foam filling. **13.00**

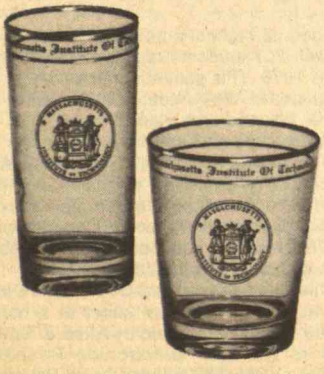
M.I.T. PLAQUE. Bronze seal mounted on solid walnut shield or rectangle. Comes with self-adhering brass nameplate. **27.95**
For two lines of engraving, add 7.00

M.I.T. INSIGNIA TIE. A distinctive way to show off the M.I.T. shield. Fine quality polyester with repeat pattern on maroon or navy ground. 3½" wide. **8.00**

INSIGNIA GLASSWARE. Hand-blown with silvery M.I.T. seal and platinum rim. Available in Hi-ball, Single or Double Old Fashioned. each **2.50**

DIRECTOR'S CHAIR. Sturdy folding hardwood frame in natural or black finish. Seat and back in heavy white cotton duck with 3-color M.I.T. seal. **40.00**

DIRECTOR'S CHAIR with walnut finished hardwood frame. **47.00**



the Coop

M.I.T. Student Center
84 Massachusetts Avenue
Cambridge, Mass. 02139

Quan.			TOTAL
____	M.I.T. Chair, cherry arms	Express Collect 95.00	____
____	M.I.T. Chair, all black	Express Collect 95.00	____
____	M.I.T. Chair Cushion	13.00	____
____	M.I.T. Insignia Tie in navy	8.00	____
____	M.I.T. Insignia Tie in maroon	8.00	____
____	Hi-ball Glasses	2.50	____
____	Single Old Fashioned	2.50	____
____	Double Old Fashioned	2.50	____
____	Director's Chair ( ) natural, ( ) black	40.00	____
____	Director's Chair in walnut	47.00	____
____	Plaque	27.95	____
____	Engraving	7.00	____
	( ) Shield, ( ) Rectangle		

Name to be Engraved _____
Class of _____

Please ship to: _____
Street _____ City _____
State _____ Zip _____
Ordered by: _____
Street _____ City _____
State _____ Zip _____
COOP # _____

☐ CHARGE MY ACCOUNT ☐ OR I ENCLOSE REMITTANCE

Mass. Residents: Add 5% sales tax (except ties).
Out-of-state Residents: No tax except when delivered in Mass.

SHIPPING AND HANDLING (Continental U.S.A.)

		N.E. States	East of Miss.	West of Miss.
Director's Chair, Glassware	(per order)	2.50	3.50	4.50
Personalized Plaque	(per order)	1.25	1.75	2.25
M.I.T. Chair Cushion & Tie	(per order)	1.00	1.25	1.50

M.I.T. Chairs: Freight charges collected upon delivery.
Please allow approximately 4 weeks for delivery.

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE

III

Materials Science

Melvin C. Chang, Sc.D. '51, has opened a consulting office in Lafayette, Calif. . . . **Ilan A. Blech,** Sc.D. '64, of the Department of Materials Engineering at the Technion-Israel Institute of Technology, visited M.I.T. to give the Jacob Kurtz memorial lecture. His topic was "Electronic Materials Research in Israel and its Role in the Development of the Electronics Industry."

Richard E. Mistler

Richard E. Mistler, Sc.D. '67, left Western Electric's Princeton Laboratories in June to join Plessey Frenchtown as head of its research and development department.

David A. Higbee, S.M. '65, has been named country product manager in Mexico for the bar, rod and wire products of Armco International. Mr. Higbee has been assistant to the general director since he transferred to Mexico in 1977.

William G. Morris

William G. Morris, Sc.D. '63, has been named manager of the newly established microstructural analysis project at the General Electric Research and Development Center. In his new position, Dr. Morris will direct the activities of a group involved in surface analysis, x-ray fluorescence, x-ray and electron diffraction and transmission electron microscopy.

XI

Urban Studies and Planning

Edward R. Hermann, S.M. '49, professor of occupational and environmental medicine at the University of Illinois Medical Center, has been honored with a Merit Award by the Chicago Technical Societies Council. Dr. Hermann's accomplishments include the development of a waste-water treatment system based on findings from work on algal photosynthesis in conjunction with bacterial oxidation. He has also formulated a biophysical law describing hearing losses due to noise. Prior to accepting the appointment at the University of Illinois, Dr. Herman served as director of public health for the United States Atomic Energy Commission in New Mexico, where he also was involved in research on the treatment and disposal of nuclear waste. . . . **Dean Johnson,** '74, has been appointed director of the Special Legislative Commission for the Adequacy of Water Supply in Massachusetts. He is a former principal of Justin Gray Associates where he specialized in assessment of the environmental impacts of major projects, including Park Plaza in Boston.

XVI

Aeronautics and Astronautics

Robert C. Duncan, Sc.D. '54, vice president of engineering at Polaroid, has been elected to the Corporation of Boston's Museum of Science. . . . **Charles A. Vehlow,** S.M. '77, has been graduated from the Naval War College in Newport, R.I. During the 10-month course, he studied the elements of strategy and policy, defense economics and decisionmaking.

VI-A

Cooperative Course in Electrical Engineering and Computer Science

VI-A reached its highest enrollment in its history this fall, with 207 students registered as of September 11, 1978. This past summer also saw the largest number of VI-A students out on work assignment at any one time, namely, 194.

June saw the largest single new class enter the Program — a total of 79. This means that currently 29.8 per cent of the sophomore class in Course VI is enrolled in VI-A and the Program now encompasses 15.5 per cent of the entire Department of Electrical Engineering and Computer Science at the junior, senior, and graduate levels.

During his summertime West Coast visits Director **John A. Tucker** was the guest at a home-cooked Chinese dinner hosted by **Allen J. Baum,** '73, who is with the Electronics Research Laboratories of Hewlett-Packard Co. in Palo Alto, Calif. Also attending the dinner were Mr. and Mrs.

William R. Bidermann, '76, **Paul E. Braisted,** '79, **Ludek Dadok,** '80, **Alan M. Marcum,** '78, Mr. and Mrs. **Eric A. Slutz,** '74, **Kenneth A. van Bree,** '71, and Mr. and Mrs. **Laurence G. Walker,** 73 — all of whom are also associated with Hewlett-Packard labs in Palo Alto.

Mr. Tucker, during his visit, also had lunch with **H. DuBose Montgomery,** '7l. DuBose is with the management firm of Kirk, Knight and Co., of Menlo Park, Calif. He is also President of M.I.T.'s Alumni Club of Northern California.

Mr. Tucker also spent a delightful afternoon visiting Professor (Emeritus) **Yuk Wing Lee,** '27, and his wife Betty at their lovely home in Belmont, Calif., just south of San Francisco. It was a treat to see their beautiful flower gardens and to renew our acquaintanceship over tea and cake.

On August 18th **Cecil H. Green,** '23, hosted his annual Texas Instruments VI-A luncheon. Mr. Green invited the ten T.I. VI-A students and their managers to the luncheon which was held downtown at the Dallas Petroleum Club. Head table guests included, among others, **C. Morris Chang,** '52, T.I. Group Vice President and **Dean R. Collins,** '58, of T.I.'s Central Research Labs; Director Tucker addressed the gathering after lunch.

On M.I.T. Day in June two VI-A Alumni from the 50-year class visited the VI-A office: **Montague S. Burgess** and **Francis C. Sweeney.** On that same day, at a reception for **Harold S. Osborne,** '08, we greeted the following VI-A Alumni: **Jerome L. Abel,** '58, **A. Rufus Applegarth, Jr.,** '35, **Gordon K. Burns,** '34, **Lung C. King,** '26, **Robert B. Parente,** '58, and **Lawrence G. Peterson,** '36.

On September 5, 1978, a reception was held at the New England Aquarium for Mrs. and Dean **Harold L. Hazen,** '24, to celebrate their Golden Wedding Anniversary. Professor (Emeritus) **Karl L. Wildes,** '22, formerly associated with the VI-A Office; **Eugene W. Boehne,** '28, VI-A Director from 1947-1959; Professor **J. Francis Reintjes,** VI-A Director from 1960-1969; **W. Gordon Bowie,** '29; **Edwin L. ("Ted") Rose,** '21, and Director Tucker were all there.

The following VI-A students have joined the firms which had them on the VI-A Program: **Giles A. Pauli,** '78, Texas Instruments in Austin, Tex.; **Charles B. Dieterich,** '77, R.C.A. Labs in Princeton, N.J.; **Michael N. Geselowitz,** '78, with the Naval Surface Weapons Center in White Oak, Md.; and **Leon K. Woo,** '76, with Raytheon's Equipment Division in Wayland, Mass.

Alumni who have stopped by the VI-A Office (Rm. 38-473) recently include (in addition to some of those already mentioned above): **Maurice J. Aghion,** '75, **Richard L. Fossett,** '33, **John F. Longley,** '33, and **Michael J. Marcus,** '68.

It is with sadness we note the passing of **Robert P. Shaw,** '23, on August 3, 1978 in Bath, Maine.

We encourage any of you who may be in the area to stop by and visit us in the VI-A Office located in the Sherman Fairchild Electrical Engineering and Computer Science building at 50 Vassar Street. — **John A. Tucker,** Director, VI-A Program Office, Rm. 38-473, M.I.T., Cambridge, Mass. 02139.

A Lesson About Innovation Unlearned Since the Wright Brothers

Remembering Wilbur and Orville Wright's achievements of 75 years ago, we forget their frustrations. But the lesson which the country might have learned through its callous response to the Wright brothers' achievements remains unlearned even today: the gap between the laboratory and the marketplace is as wide now as it was then, says **Arthur S. Obermeyer,** Ph.D. '56, President of Moleculon Research Corp. of Cambridge.

Speaking in support of the National Science Foundation's Small Business Innovation Program, Dr. Obermayer recalled some history for a joint hearing of the House and Senate Small Business Committees in Washington late last summer.

Two weeks after the historic flights on December 17, 1903, Senator Henry Cabot Lodge called them to the attention of the War Department. After two years of government inaction, the Wright brothers were told that the U.S. would "decline to make allotments for the experimental development of devices for mechanical flight." The Ordnance Board of the War Department "did not care to formulate any requirements for the performance of a flying machine."

It was five years before the Army put up $25,000 for research, and even then President Theodore Roosevelt had to intercede to be sure that the contract went to the Wright brothers instead of some ill-qualified competitors.

The lesson of this story, which Dr. Obermayer paraphrased for members of the House Committee, is that the Wright brothers might well have done no better today. "Today's inventor/entrepreneur finds financial support no easier to obtain than he did in the Wright brothers' day. Only on rare occasions have the fruits of basic research found their way into commercial products or processes," Dr. Obermeyer declared.

"We have not been effective at bridging the gap between the laboratory and the marketplace."

A principal reason, Dr. Obermayer said, is the government's reluctance to capitalize on the potential of individuals and small companies, where innovation is likely to flourish. Small business now receives but 1 per cent of the National Science Foundation's grants and accounts for less than 4 per cent of the total federal research and development budget, and both figures are "much smaller" than they should be.

Dr. Obermayer's Washington appearance was in support of the National Science Foundation's Small Business Innovation Program, which he called "a fresh new approach to combine the interests of the government with those of small, innovative technical companies and venture capital. [It] can have potentially a tremendous impact on our economy," he told Committee members.

ALUMNI TRAVEL PROGRAM 1979-80

This special travel program, to some of the most interesting areas in the world, has been especially designed for alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Dartmouth, Univ. of Pennsylvania and certain other distinguished universities and for members of their families. It is consciously planned for persons who normally prefer to travel independently, and covers lands and regions where such persons will find it advantageous to travel with a group.

The itineraries are designed for the intelligent traveler, and offer an in- depth view of historic places, ancient civilizations, archeological sites and artistic treasures, as well as interesting and far-flung cultures of the present day and spectacular scenery from virtually the four corners of the globe. The programs are, however, also planned to incorporate generous amounts of leisure time and to avoid unnecessary regimentation so as to preserve as much as possible the freedom of individual travel, while utilizing the savings and the practical convenience which group travel can offer.

Considerable savings have been obtained by using special reduced fares offered by the world's leading scheduled airlines, fares which are generally available only to groups or in conjunction with a qualified tour and which offer savings of as much as $500 and more over normal air fares. In addition, special group rates have been obtained from hotels and sightseeing companies. By combining these savings with a careful selection of the finest available hotels and facilities, it is possible to offer travel arrangements of the highest standard at moderate and economical cost.

AEGEAN ADVENTURE — 23 Days: The archeological treasures of classical antiquity in Greece and Asia Minor and the islands of the Aegean, with visits to Constantinople (Istanbul), Troy, Pergamum, Smyrna (Izmir), Sardis, Ephesus, Epidauros, Mycenae, Olympia, Delphi and Athens, as well as a cruise through the Aegean to the islands of Crete, Santorini, Mykonos, Rhodes and Patmos. Departures April through October.

MEDITERRANEAN ODYSSEY — 22 Days: An adventure into realms of antiquity in the western Mediterranean, with the ruins of Carthage and the Roman cities of Africa in what is now Tunisia, the splendid Greek temples of Sicily (including the famed "Valley of the Temples" at Agrigento and the ruins of Syracuse, the city of Archimedes), the remarkable Norman churches of Palermo, dating from the age of William the Conqueror, and the fortress cities of the Crusader Knights of St. John on the island of Malta. Departures March through October.

VALLEY OF THE NILE — 17 Days: A detailed view of one of the greatest civilizations the world has ever known, the civilization of ancient Egypt along the valley of the Nile. The itinerary includes Cairo, the pyramids of Giza, Sakkara, Dashur and Meidum, Memphis, Abydos, Dendera, the great temples and monuments of Luxor, including the Valley of the Kings and the tomb of Tutankhamun, and a cruise on the Nile of Upper Egypt to visit Esna, Edfu, Kom Ombo and Aswan, as well as the great monumental temples of Abu Simbel near the border of the Sudan. Departures January through December.

THE ORIENT — 29 Days: A magnificent survey of the Orient, including the exotic temples and palaces of Bangkok and the ruins of ancient Ayudhya, the great metropolis of Singapore, the enchanted island of Bali with its unique artistic heritage, the famed port of Hong Kong on the border of Red China, and a comprehensive visit to Japan which places special emphasis on the cultural treasures and the tranquil beauty of classical Japan at the historic city of Kyoto and at Nara, Uji, Kamakura and Nikko, as well as the mountain scenery of the Fuji-Hakone National Park and the modern capital at Tokyo. Optional visits are available to the ancient temples of central Java and the art treasures of the National Palace Museum in Taiwan. Departures March through November.

BEYOND THE JAVA SEA — 32 Days: A remarkable journey through the tropics of the Far East, from the port of Manila in the Philippines to the tea plantations and ancient civilizations of Ceylon, the Malay Peninsula, the Batak tribes of Sumatra, the ancient temple ruins of Java, the fabled island of Bali, headhunter villages in the jungle of Borneo, and the unforgettable beauty of the lights of Hong Kong. Departures January through November.

MOGHUL ADVENTURE — 30 Days: The great historic and cultural heritage of India, combined with the splendor of ancient Persia and a journey into the high Himalayas in the remote mountain kingdom of Nepal: imposing Moghul forts, ancient temples, lavish palaces, the teeming banks of the Ganges, snow-capped mountains, picturesque cities and villages, and the Taj Mahal, culminating with the famous mosques of Isfahan and the 5th century B.C. palace of Darius and Xerxes at Persepolis. Departures January through November.

SOUTH AMERICA — 28 Days: An unusually comprehensive journey through the vast continent of South America, from the Inca ruins and colonial heritage of the western coast, amid the towering snow-capped Andes, to the great Iguassu Falls and the South Atlantic beaches of Brazil. The itinerary includes the colonial cities of Bogota, Quito and Lima, the great Inca centers of Cuzco and Machu Picchu, La Paz and Lake Titicaca, the magnificent Argentine Lake District at Bariloche, Buenos Aires, the Iguassu Falls, Sao Paulo, Brasilia and Rio de Janeiro. Departures January through November.

THE SOUTH PACIFIC — 28 Days: An exceptional tour of Australia and New Zealand, with Maori villages, boiling geysers, fiords and snow-capped mountains, ski plane flights, jet boat rides, sheep ranches, penguins, the real Australian "Outback," historic convict settlements, and the Great Barrier Reef. Visiting Auckland, the "Glowworm Grotto" at Waitomo, Rotorua, the Southern Alps at Mt. Cook, Queenstown, Te Anau, Milford Sound and Christchurch in New Zealand, and Canberra, Tasmania, Melbourne, Alice Springs, Cairns and Sydney in Australia. Optional extensions available to Fiji and Tahiti. Departures January through November.

EAST AFRICA — 21 Days: A distinctive game-viewing and photographic safari to the wilds of Africa, covering some of the greatest wildlife areas in the world. From the semi-desert of Kenya's Northern Frontier region and the vast game-filled plains of the south to the lakes of the Great Rift Valley and the snow- capped peak of Kilimanjaro, the itinerary includes Nairobi, the Nairobi National Park, Treetops, Meru National Park, Samburu Game Reserve, the Mt. Kenya Safari Club, Lake Nakuru National Park, Lake Naivasha, an extended stay in the great Masai-Mara Reserve, Amboseli National Park and Tsavo National Park, with optional visits to the coast at Mombasa and Lamu. Departures January through December.

Prices range from $2,295 to $3,575 from U.S. points of departure. Fully descriptive brochures are available on each tour, setting forth the itinerary in detail with departure dates, relevant costs, hotels used, and other information. For full details contact:

ALUMNI FLIGHTS ABROAD

White Plains Plaza, Dept. TR11, One North Broadway, White Plains, N.Y. 10601

12

It is with sincere regret that I report the passing of **Harold Manning** on July 30, at the age of 89. His home had been in Waterbury, Conn., but he had been living at the Hickory Lane Rest Home at Woodbury, Conn., since his wife died several years ago. Harold was a member of the Rotary Club, the University Club (which he served as program chairman for many years), the Country Club of Waterbury, the First Congregational Church of Waterbury, and he was an honorary member of the Waterbury Club. Harold had practiced patent, trademark, and copyright law for many years, and was a member of the American Bar Association, the American Patent Law Association, and the Connecticut Patent Law Association. He leaves one brother, Clarence, of New Britain, Conn., and several nieces, grand nieces, and grand nephews. In this department for October, I reported visiting Harold in late June. It was good to see him; we had a fine visit, and he insisted on walking out to inspect the car I was driving.

Latest work from **Jonny Noyes** is that his second hip operation was successful. He writes that with two major operations, six months in the hospital, and no out-door exercise, he has lost 45 pounds, and he says that his pep has gone down at the same rate. He is gaining strength slowly and gets about with a walker. He is now living at the Crestview Community for Senior Citizens in Bryan, Texas (P.O.Box 4008, zip 77801), where he expects to be for some time.

Wallace Murray is in the Seaside Nursing Home, 850 Baxter Blvd., Portland, Maine, telephone 642-4478. I have no details. We all wish you luck, Wally, and hope you will be up and around soon.

It would be nice if some of you "reluctant" writers would send in a note or card. We would sure like to hear from you. And greetings and best wishes for the holiday season from your secretary and his wife Julie. — **Larry Cummings**, Secretary, R.R.4, Connersville, IN 47331

13

We regret that we could not attend the Alumni Officers Conference on October 14. Although I am progressing satisfactorily, I have not driven any great distance since the cast was removed from my arm.

We have just learned from the Alumni Office that **Francis H. Achard** died September 14, 1978. His memorial service was held at Trinity Church in Newton Center on Sunday, September 17. Frank had suffered a paralyzing stroke a short time ago and had been confined to the hospital. We hope to have more details next month.

We received a short note from **Tom Lough** advising that although he is lame, he still drives his car and gets to his office a couple of times a week.

The Alumni Office advises that Mrs. Kay wrote of the death of **Vernon G. Kay** on August 10, 1977. We just received a letter from Mrs. Kay: "It is a year since my husband passed away after a year's illness but that gallant soul pursued his interests almost up to the end, still serving his clients at 85. He looked 65 at the most. Previously, he had been with Sears Roebuck & Co. developing factories and then doing private consulting work for them even after enforced retirement when they made an exception to keep him on.

"He was a very special humble man and we had 42 wonderful years together, he never losing that *joi de vivre*, and I feel a lucky woman to have been with him and learned so much, particularly now, when I must learn to cope by myself. I have warm feelings for M.I.T. and I think he was proud to have been a graduate." — Beatrice M. Kay.

That's about the news for this month. Unless we hear from you, we have nothing to report, so please write us. Happy Thanksgiving. — **Rosalind R. Capen**, Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

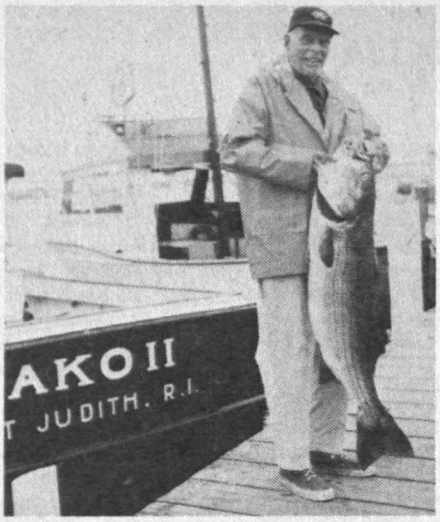
14

Werner T. Schaurte died on July 25, 1978, at the age of 85, after a long illness. He entered the Institute from Duesseldorf, was with us in Course II in our first three years and then returned to Germany. He was an army lieutenant in World War I. Early in 1917 he entered his father's firm, Bauer and Schaurte, manufacturers of bolts and nuts, and upon the father's death soon afterward took over the management. The firm had a leading part in the standardization of bolts and nuts in 1924 and were the first to import grinding machines from the United States. In 1927 Dr. Werner introduced a process for making heat-treated, high-strength bolts and nuts and a heat-treatable copper alloy for threaded parts. In recognition of his outstanding achievements, the Darmstadt Institute of Technology awarded to Werner in 1933, when he was only 40, the honorary degree of doctor of engineering. Still more achievements followed, but at the outbreak of war in 1939 Dr. Werner happened to be in Canada, was interned and was unable to return to the firm in Neuss until 1942. When the war ended, the works there were 65 per cent destroyed. Rebuilding began in 1947, and still more improvements in manufacturing methods were made. Dr. Werner retired in 1965, then devoted himself to working in conservation and became member and trustee of the World Wildlife Fund and of the International Union for Conservation of Nature. All his life he was highly interested in horses — breeding, driving and dressage. Dr. Werner is survived by his son, Christian W. Schaurte, who kindly provided nearly all the information for this note; and by three grandchildren. — **Charles H. Chatfield**, Secretary, 177 Steele R., West Hartford, Conn. 06119

16

Our mail bag is unusually light this month. Indirectly, we heard that **Frank Darlington** con-

Werner T. Schaurte, '14, manufacturer of nuts and bolts and recipient of an honorary degree from Darmstadt Institute of Technology.



The whale got away, but Edmund S. Parsons, '16, did catch a whale of a fish — a 45-lb. striped bass.

A Whale of a Tale

If there was a contest among fishermen on "the big one that got away," Ed Parsons, '16 would win by a mile — well, by 40 feet anyway.

It all began on an ordinary fishing expedition — Bob Linton's charter boat out of Snug Harbor (Rhode Island) and ended on the front page of the *Providence Journal*. About five miles south of Block Island while trolling for bluefish in 100 feet of water, Ed was hit with a blue. However, before he could bring it in, the fish managed to get off and something else managed to get on. When this "something" had taken close to 240 feet of wire line from the reel, Ed called for help. Mr. Linton came to the rescue, but the line continued to run out to the nylon backup and broke. With all looking on, a big black corrugated head with a rounded nose surfaced 500 feet from the boat. The creature closed in and began to circle the boat as close as 100 feet. From the bridge, Linton observed that the body was longer than his boat — a 45-footer. "I think it's a humpback whale," he called.

In the end it was Ed Parsons and his companions who were "the ones that got away!" Back on the mainland, a call to Dr. Howard Winn, a whale expert at the University of Rhode Island, confirmed that the description fit a humpback whale, and an extra large one at that. Bob Linton claims he's never seen anything like it in 31 years of professional sport fishing. — *S.K.*

tinues to spend a part of his time in Hyannisport. "My legal voting residence since 1916 has been Leetsdale, Penn., a suburb of Pittsburg. Cape Cod has been my vacation home since 1897 (Vacations varied from two weeks to five months after retirement in 1930.)" . . . Had a nice note from **Jap Carr** in which he summarized the participation of our class in donations to the Alumni Fund.... . From **John Fairfield** we received a recent letter that he received from **Dina Coleman** with John's comment, "We're proud of Dina's civic services". Dina wrote to John: "Thanks again for your birthday note. It shows we are both alive and breathing. There has been no change in my family or in the various "do-good" enterprises. The cost in all of them is escalating which makes fund raising that much tougher. My next enterprise is a performance of 'Don Pasquale'. It's supposed to be funny. I hope so."

We regret to report the passing of **Frank Holmes** on September 18, 1978. He and Mildred had been regulars at our reunions, and missed our 62nd because Frank was hospitalized for surgery at the time. Shortly thereafter, he wrote that he was doing fine and planned to spend the summer at their summer home in Fitzwilliam, N.H.

We also regret to report the passing of **Ralph Forsyth**, who along with his wife, Isabel, had in recent years been attending our reunions. Isabel wrote: "We both enjoyed the 1916 reunions. May they continue for some time yet! Keep your letters coming and keep breathing. — Acting Secretary, **Ralph A. Fletcher** P.O. Box 61, West Chelmsford, Mass. 01863

17

Tom Ryan has suffered three hip operations and Mrs. Ryan writes that his recovery has been slow. All their five children are now out of the nest; Tom, Jr. is a public interest lawyer, while the youngest attends graduate school at the Maryland Institute of Art. . . . **Al Moody** writes from Denver that he is enjoying life and sends greetings to all in the Class of 1917. . . . **Howard Melvin**, our Vice President for the Pacific Coast, writes that his health is very good and he couldn't be in better spirits except that his golf handicap keeps growing larger.

Art Dickson wasn't able to attend the 61st Reunion, as his wife, Ruth, just had a serious eye operation and needs still to be careful. . . . Betty and **Ken Lane** circumnavigated southern Florida last April. Ken is still involved with his Coast Guard auxiliary activity. . . . **Al Ferretti** was in Ireland in October; hence unable to attend the 61st Reunion. Al sent his greetings to all the Class.

Sorry to report the death of **Joselph L. Calabro** at his home in Quincy, Mass., on September 2, 1978. We also have a report of the death of **William F. Tuttle** on July 14, 1978, at his home in Middletown, Ohio. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

18

I trust this past season for enjoying outdoor activities found you doing just that. Summer is notable for the doldrums — particularly when it comes to news from any of you. I am therefore grateful for this report by the Brookline School Department on **Len Levine**'s activities:

"Leonard Levine, described by industrial arts teacher Joe Chiasson as a 'super, concerned guy who makes an invaluable contribution in the classroom,' is one of Brookline's most dedicated school volunteers. Every weekday, Len walks the short distance from his apartment to Brookline High where he assists the teacher in two Technical Drawing classes. 'I circulate around the room, help kids on the drafting table. And if I find that a student is not catching on quickly, then I sit down and show him or her how to do the drawing,' says the outgoing gentleman who wears a snappy brown bowtie. He makes it quite clear that his volunteer teaching has enriched his life just as it has benefited those students who have known his expertise and patience."

Your Secretary and Selma went with Elizabeth (Mrs. **Julian**) **Howe** on a most enjoyable weekend visit in late August as guests of Dorothy (Mrs. **Edwin**) **Rossman** at Paris Hill, Maine. It was a most pleasant reunion. We all felt that Ed and Julie would have been pleased to know that the ties that bind us together remain unbroken. . . . Earlier this summer we visited Hazel (Mrs. **Saxton**) **Fletcher** at the New England Hospital in Boston just before she underwent a serious operation. We are happy to report that she is back home in Greenfield, N.H., and is making a good recovery. . . . Among my customers is a large distillery whose chief engineer is Ralph Porter. A conversation with him yielded the information that he is not only an alumnus but the son of our own **Garnett (Ralph) Porter**, deceased so many years ago.

It is my sad lot to record the death of **Pete Harrall**. I was fortunate to have been close to Pete these past few years. Here was an unusual man — modest, loyal, and a participant in good works. None of us who attended our 60th Reunion can forget his courage and devotion in making his final trek to the M.I.T. he loved. We will miss him. — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

19

The response from 1919 classmates concerning the 60th Reunion is encouraging! There were, at this time of writing, 42 replies. Potential attendees for the reunion, are: **Bristol, Blye, Bond, Bassett, Jr., Burbank, Denison, Doten, Flynn, Gilbert, Grayson, Hunter, Holmgren, Hewes, Kitchin, Kenison, Langille, Loucks, de Lima, Mayer, Michelson, Moore, Phelps, Quick, Palmer, Reis, Riegel, Sheeline, Shea, Stevens, Svenson, Saunders, Sansberry, Morton Smith, Staubach, Vogt, Williams, Winkfield, Webster, Way, Wolfe.** There will be furher information in the next issue.

George Michelson writes that he is maintaining his health and going to business every day — as he says "wearing out instead of rusting out." . . . **Edmund Flynn** writes a long letter recalling a past association with **Gene Smoley** and regrets his passing, as do many other classmates. . . . **Tim Shea** and his wife celebrated their 56th wedding anniversary in Colorado Springs and Albuquerque, and Tim attended an energy research conference at the Sandia Laboratories. . . . **Arnold Staubach** sends a change of address: 4718 Hallmark Lane, Houston, Tex. 77056. . . . **Ralph Gilbert** writes that he enjoyed our last reunion and plans to attend the 60th.

Following are some post card responses (too numerous to include in total in this issue). De Lima opts for rooms in one of the hotels near the Institute. **Jim Reis** would prefer some place other than Cambridge. **Larry Riegel** must stay close to home owing to his wife's health. **John Stevens** finds travel more a chore. **Dean Webster** says he plans to be present at the 60th. **Don Way** writes of a pleasant stay near Bristol, N.H.

Future notes will give you more news. — **W. O. Langille**, Secretary, Box 144 Gladstone, N.J. 07934

20

A heartwarming letter from Vera Howes, widow of our beloved classmate, **Homer Howes**, tells of a recent visit to the Red Lion Inn at Stockbridge. "What a good time we had there at the forty-fifth," she writes, and all of us who were there will second the notion. Vera is in good health and continues to do a fair amount of globe-trotting.

Another bit of good news: our Class can proudly report that no less than 63 per cent of its active members contributed this year to the Alumni Fund. No other class since 1920 boasts such a majority of giving (with the (exception of the 40-year Class of 1928). Due recognition should be given to our stalwart Class Agents for the Fund, **Al Burke** and **Perk Bugbee**.

It is with sorrow that I report the deaths of three classmates. **Carl E. Carlson**, long a resident of

Baytown, Tex., died on June 29. **Aksil P. Andersen** died in Amherst, Mass., on February 5; Aksil was formerly a professor of civil engineering at the Technical University of Trondheim in Norway. One of our most distinguished classmates, **Harold F. Smiddy**, died on September 9. Harold was an internationally recognized authority on corporate management. After serving in the U.S. Army in World War I, Harold became an officer and director of Electric Bond and Share Co. and its subsidiary, Ebasco Services, Inc. He was a partner for several years with the management consulting firm of Booz, Allen and Hamilton. From 1948 until 1961 he served as vice president of General Electric Co. He was a life member of the American Institute of Electrical Engineers, the Academy of Political Science, the American Society of Mechanical Engineers which conferred the Gantt Medal upon him, the National Society of Professional Engineers which awarded him the title of Distinguished Engineer in Industry, and the Council for International Progress in Management which awarded him its Wallace Clark medal. The Society for Advancement of Management conferred on him the Taylor Key. Harold headed the United States delegation to the Ninth International Management Congress in Brussels in 1951. He was an officer of the Conseil International pour L'Organisation Scientifique and of the Institute of Management Sciences. He served as a director of the American Arbitration Association, a trustee of Ithaca College, and a member of the Advisory Council of the graduate school of business at Columbia University. In 1963 he was President of the American Academy of Management. Harold is survived by his wife Lois. He contributed considerable lustre to the Class. We honor him for his achievements. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

21

Class news is scarce this month, and unfortunately most of it concerns a decrease in our members. Time marches on.

Betty (Mrs. **Dugald C.**) **Jackson** died April 29 at her home in Havre de Grace, Md., outliving her husband only a year. She attended a number of reunions with Dug, and many will remember her quiet, gentle ways.

Death notices of five more classmates have been received: **Robert E. Manley**, Charlottesville, Va., January 29, 1977; **Sidney Senzer**, Mamaroneck, N.Y., December 25, 1977; **William Thompson Smith**, Larchmont, N.Y., March 16, 1978; **Alexander J. Lapointe**, Birmingham, Mich., July 3, 1978; and **Roy A. Wehe**, San Mateo, Calif., July 31, 1978.

The only information I have on Robert Manley is that he was Assistant Supervisor — Processing for Texas Co. in the early 1950s and a petroleum consulting engineer ten years later. W. T. Smith worked for many years with Ford, Bacon and Davis.

Alex Lapointe returned to M.I.T. after graduating from Course X to do research in colloid and surface chemistry and rubber technology. He worked for Devoe and Reynolds, Sherwin-Williams, and Glidden companies and during World War II worked on the development of military aircraft coatings for the U.S. Army and Navy. Later he spent 14 years with the Ford Motor Co. managing their chemical engineering and materials laboratories and developing coating materials, methods, and equipment. He held a number of patents. I am informed that at one time Alex debated between music and science as a career. He played violin in chamber music groups and three symphony orchestras.

The distinguished career of Roy Wehe was covered in a "life history" solicited by Sam Lunden and summarized in these notes in January, 1978. At the memorial services tribute was paid to Roy's "generosity, service, modesty, helpfulness, and thoroughness." A formal In Memorium was sent to Mrs. Wehe by the California Public Utilities Commission, which referred to his expertise in utility regulation, his integrity, and his personal warmth. The August 8 meeting of the San Mateo

Martha Munzer, '22 — teacher, seeker, dreamer and doer — looks across the seasons of her life focusing on events which have shaped it in her book, Full Circle: Rounding Out a Life.

Persistence for the Honor of Her Sex

"As for me, in my present stage of questing I am groping for a valid connection between the manifold findings of science and the intuitive insights of religion," states Martha Munzer, '22, in her new book, *Full Circle: Rounding Out A Life* (New York: Alfred A. Knopf, 1978).

Mrs. Munzer recalls entering M.I.T., "a man's school," at a time when women students lived in a hotel because there were no dorm rooms for them. Dissuaded by the dean ("Young lady, this is no place for you"), Martha passed the entrance exams anyway and went on to complete a degree in electrochemical engineering. "It was hard, hard work," she says, "for I'm not a natural-born scientist, if such there be. But I felt that the honor of my sex was at stake, so I persisted."

Upon leaving M.I.T. she married, had three children, and for many years taught high school chemistry. Since 1954 she has been a teacher, writer and lecturer in the field of conservation and environmental planning, and has had eight books published. These books, begun in her role as staff member with the Conservation Foundation, are directed towards young people and pass along the insights she gained from traveling around the country to learn how people were tackling the job of restoring and renewing their particular habitats in both rural and industrial settings.

In her current book Mrs. Munzer talks openly and honestly about herself, her life and the events which shaped and gave meaning to it. Of mid-Victorian parents she remembers one of the favorite family 2 a.m. "discussion" questions — "Is it sinful for young people to kiss before becoming engaged to be married?" Although the present generation may not encounter the problems of ignorance and repression that she faced, Mrs. Munzer is aware that they have their own special set of difficulties. Her warmth, understanding and flexibility seem to have aided her well in totally escaping the "generation gap."

Mrs. Munzer refers to herself as "an absent-minded professor, a sun-worshiping basker and a water-loving fish." She discusses aging and its significance, the worth of one's individuality, and reflects upon personal discoveries which have enhanced her life. Over the years she has collected some principles for a happy life: learn to "forget" selectively; be willing and ready to take a chance when the next step points in a new and untried direction; always reach a bit beyond one's grasp; and keep learning, marveling and laughing. — *S.K.*

When they first went to work for Aramco in Saudi Arabia in 1938, their fellow-workers at Geophysical Service, Inc., who stayed behind in Dallas called the travellers "doodlebuggers." Among these pioneers to that then-exotic land was Cecil H. Green, '23, who went as President of G.S.I. to see how its crews were doing and what their life was like. This summer, to celebrate the 40th anniversary of G.S.I.'s presence in Saudi Arabia, all the "doodlebuggers" came together for a boisterous reunion in Dallas. And John Babb, who was the leader of G.S.I.'s second Saudi Arabia crew, gave Mr. Green an authentic Arab headdress. (Photo: G.S.I. Grapevine*)*

City Council was adjourned in Roy's honor. Roy was a past member of the City Council and also was Public Works Commissioner.

The sympathy of the class is extended to the families of these deceased classmates.

A change of address has been received for **Leo C. Pelkus**. His new address is 38 Oak St., Wellesley. Mass. 02181.

A note on an Alumni Fund envelope from **Harry Butters** said, "Hi! Still alive and breathing. I'm a twice a week user of the springboard at M.I.T.'s pool. Anybody for a back somersault?" — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

22

Since the Thanksgiving and Christmas season is approaching, please send your secretary greeting cards with class news for immediate use.

We received an article on nylon production in which **Crawford Greenewalt** tells of the early days. This story of laboratory technology and extensive research is a most interesting saga in American industrial development.

The sympathy of our Class is extended to the families of **George W. Heathman**, 73 East Dixon Ave., Dayton, Ohio; **Frederick W. Wiegand**, P.O. Box 12652, San Antonio, Tex.; and **Arthur J. Frappier**, c/o James Nigley, 506 Claflin Ave., Mamaroneck, N.Y.

We have also received information on the death of **John C. Molinar**, Randolph Hill Rd., Randolph, N.H. 03593. He served as a police commissioner and President of the Republican Club in Darien, Conn. He was also a member of the Randolph Foundation and the Mount Crescent Water Commission. Memorial services were held June 10, 1978. . . . And, sympathies go to the family of **Hilary S. Swenson** of 88 Shipyard Ln, South Dartmouth, Mass. He was employed by the Morris Twist Drill Co. as a chief metallurgist until his retirement.

We are glad to hear of the continued support by our Class for the Alumni Fund and Special Gifts Program. . . . The Arthur Fiedler Sunday night concerts here in Buffalo bring enjoyable remembrances of our evening at Symphony Hall during our class reunion in 1977. Let's do it again.

And now, to repeat, please send cards or letters with news. Don't send money as I am only . . . **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fl. 33060

23

We have learned from Phyllis Davenport that **Sixto E. Duran-Ballen**'s son, Sixto A. Duran-Ballen, who was born in Boston and graduated from Columbia University, is a leading contender for election as President of Ecuador. In the July 17 election he was a very close second in a field of six candidates, so that a run-off election was scheduled for September. At this writing the result has not come in, so tune in next month to learn the outcome. This election is of considerable importance and interest because it is the first presidential election to be held in Ecuador in ten years. The country has been ruled by a three-man military junta for the past six years.

Roger Phelps writes that he has been retired from business for a number of years and continues to live in Oakford, Penn., though he misses Boston, where he was born in 1895.

Recently Vivian and **Dick Frazier** journeyed to Mahwah, N.J., to inspect a new granddaughter, Anne Schuyler Frazier. Her father, Andrew Schuyler Frazier, says that she will be Class of 2000 at the Institute. Enroute home they went by Marge and **Tom Round**'s place in Heritage Village, Southbury, Conn., and obtained the Class files, which Tom had in excellent order. Your new secretary is now in business. Marge and Tom were gracious luncheon hosts at a nearby inn.

Royal Sterling writes that **Fernando de la Macorra** died on August 8 in Mexico City. Fernando, Royal, and **Roger Cutting** were roommates as undergraduates. Fernando had come to Boston with his wife, daughter, and granddaughter for the 55th Reunion but had to be hospitalized there for ten days and then flew home. He was a native of Mexico and graduated with our class in mechanical engineering. He was a paper manufacturer in Mexico and was Director of Cia. de las Fabricas de Papel de San Rafael y Anexas, S.A., and served on the boards of several other organizations.

The *Portland* (Maine) *Press Herald* reports the death of **Bob Shaw** on August 3, in Bath, Maine. He was president of our class in our freshman year and again from 1923 to 1949, and was very active in undergraduate affairs. He received the bachelor's and master's degrees in the cooperative course in electrical engineering. He worked for a brief time for the General Electric Co. in the street lighting department, served as Executive Secretary of the National Research Council to the 1933 Chicago World's Fair, was Director of the Museum of Science and Industry in New tor of the New York City Hall of Science. In more recent years he was a consulting management engineer in New York City and in Florida, retiring in 1975. — **Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, Mass. 01890, Telephone (617)729-3114

24

The paucity of news from classmates must be attributed to their interest in the poker game at Camp David, with Carter dealing and Sadat and Begin holding their cards close to the chest.

We regret to report the death of Col. **William W. Sturdy** on June 19 in Truro, Mass. Bill earned his S.B. in electrochemical engineering, and he was a member of several organizations while at the Institute, including four years in the orchestra. He was with A.T.&T. until he began active duty in the Regular Army of the U.S., stationed in Heidelberg, Germany, in 1949. At a later date he returned to the technical staff of Bell Telephone Labs in New Jersey. He became somewhat incapacitated after an automobile accident but thoroughly enjoyed his Cape home. Jane expects to remain in Truro and welcomes Bill's friends and classmates.

On the brighter side, your scribe recently talked with **Eric R. Brater** in Cleveland, Ohio. He and Marie remain ecstatic about their 50th Reunion experience and are looking to the 55th. Eric — he is 82 — was my first acquaintance on opening day at the Institute in 1920. He has had a remarkable career in mechanical engineering; in addition, as an avocation, he began studying concert-level piano at age 40; and his prize-winning ability at painting has resulted in a recent commission of a 2½-by-5-foot seascape.

Frank Shaw and Barbara, **Ed Moll** and Rene, and **Phil Blanchard** and Besse planned to meet on September 23 in Sunapee, N.H. to view the foliage and discuss the 55th Reunion agenda, including prospective Class officers. Suggestions for nominees and activities are welcome and solicited. The Exeter Inn, Exeter, N.H., has been reserved for June 8, 9, and 10, 1979. It is very possible that we will visit the Portsmouth Naval Yard and possibly enjoy lunch there in the Officers' Quarters. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, Co-Secretary, 8 Pilgrim Rd., Waban, MA

25

It is a pleasure to report receiving a letter from **Bill Brown**, one of our Course III classmates. He and

his wife reside in Brunswick, Maine, and Bill says that as the years pass by the reading print gets smaller, the stairs steeper and in the north country the snow shovel gets heavier. There are many activities to attend at Bowdoin College and at the Evergreen Club (for the elderly in Brunswick). Shore parks and beaches are readily accessible during the summer months. When M.I.T. teams visit Bowdoin, Bill is a supporter and rooter.

Another welcome letter comes from **Gil Delugach** in Memphis, Tenn. Gil is now retired from the real estate building and development business and finds time for golf and bridge. He does considerable research in the selling of covered stock options. This interesting venture, he says, can be reasonably profitable without too much risk. During the summer he and Gertrude took a car trip to Canada, accompanied by their daughter, son-in-law and one of their grandchildren. Gil is still a member of the Educational Council interviewing applicants to M.I.T. He and Gertrude plan to spend the winter in Boca Raton, Fla.

Our regular reporter **Kamy Kametani** writes from Japan. He tells of attending a reception on June 2, 1978 given by the M.I.T. Association of Japan to honor Fred Lehmann, '51, and Betty Ann, '53. Kamy asked that I let all classmates know that he is in good health and enjoying the retired life. Also, he intends to be at the 55th Reunion which is now only a year and a half away.

It is with sorrow that I report the passing of two classmates. **Richard W. Tryon** died in Springfield, N.J. on May 3, 1978. Dick's working years were spent with Humble Oil and Refining Co. (Esso now EXXON). He had various assignments starting as safety inspector and progressing over the years as process designer, economics specialist, cracking specialist, assistant head of East Coast Refineries Technical Service Division, Head of Bayway Refinery Operations Analysis Department, Coordinator of Esso Standard Manufacturing Capital Budgets, and Associate Secretary of Humble's Manufacturing Technical Committee.

Maurice M. Weiner died on July 22, 1978 at the Quincy, Mass., City Hospital. Maurice who had founded the Silverman Auto Parts Co. in Quincy in 1925 owned and operated the company for 31 years. In 1956 he became purchasing agent for the Northern Industrial Chemical Co. of South Boston; and in 1966 was named purchasing agent of the Purex Corp. of Woburn, Mass., and served in that capacity until he retired in 1976. He was a member of the Quincy Hebrew Society for more than 50 years and served as its president. He was treasurer of the Quincy Chapter, B'nai B'rith, and a member of the Congregation and Brotherhood of Beth Israel of Quincy. He is survived by his wife, Alice, two sons, a daughter, two sisters and seven grandchildren. — **F. Leroy (Doc) Foster**, Secretary, 35 Woodland Way, P.O. Box 331, North Chatham, MA 02650

26

It is such a gorgeous mid-September afternoon that the Class Notes desk has moved to the lower patio (which was awash on February 7 and adjoins the new sea wall). It is difficult to believe that it could have been so wild when it is so serene today. The waves are gently washing the rocks 30 feet below and a few lobstermen are hauling pots out in the bay. A single large sailboat is making good time with a moderately strong southwest breeze heading "down east" as the old timers along the waterfront express it.

With such a respite before the northwest winds start their cooling blasts we will give you a few bits of news as we enjoy the day. Perhpas you have been wondering about the reunion videoape which has not been mentioned in a year becaus we came to an impasse. You perhaps recall that your secretary won the assignment of editing the videotape by default. The tape itself was edited on a viewing T.V. machine at M.I.T. and slides were selected from our 50th and from previous reunions to "dub" into the tape. Then for reasons of lethargy, bewilderment and lack of the right kind of tape recorder the project stalled — a year ago! **Bill Meehan** has taken care of that by bringing his tape recorder to his Boston office where I picked it up last week. Bill is still in the project office of the University of Massachusetts but I sensed that he is becoming envious of those of us who do not have to show up regularly at an office. With Bill having provided the missing link your secretary will accept needles from any and all of you who would like to hear that the videotape editing job has been completed. (Time Out — A "Laser" sailboat has just come into view and sailed right up to our oceanfront, come about and is beating back to Rockport in the stiff breeze. It is an outgrowth of a "Sunfish" and is a cartop boat but very sophisticated for racing. To give you an idea of its success the sail number on this boat was in the 10,000 range — but it's for your grandchildren, not for you and me.) Before coming down to write the notes we called **Elton Staples** at his summer home in Chatham — had to wait for him to come down from a ladder — I meant to tell him that two of my friends, Dick Reedy, '51, and a local retired admiral fell off ladders this summer with a resulting broken arm and a broken shoulder. I hope Elton's wife Helene reads this! Elton leaves for Florida about mid-October.

We have received word of the death of **Chet Buckley** on August 6, 1978, in Sarasota, Fla. Born in Taunton, Mass., he moved to Sarasota in 1974 from River Forest, Ill., where he served from 1970 until June of this year as chairman of the board of American Gauge and Machine Co. in Elgin, Ill., and International Metals and Machines Co. in Des Plaines, Ill. He was a member of the Sara-Bay Country Club, Bird Key Yacht Club and St. Martha's Catholic Church. Mr. and Mrs. **Earl McMahon**, Mr. and Mrs. **Elton Staples** and Mr. and Mrs. **Ben Margolin** were among those present for services held for Chet at St. Mary's Church in Taunton.

Bill Davidson writes, "We will miss Chet very much. He was most active in getting the 1926 group on the west coast of Florida together. He had a wide group of friends in our class and kept in touch with them."

We regret receiving this information and for the class extend our sympathy to Chet's wife Dorothy, his daughter and his three sons.

A few months ago we reported the death of classmate **Ariel Horle** in El Paso. Ariel always made reunions when he could and enjoyed his M.I.T. relationspip. A recent letter from his bank brings the news that his will carried a substantial bequest to M.I.T., additional evidence of his fondness for M.I.T. We shall miss him at reunions. The sun is lowering and with it the temperature and the 5 o'clock mail will be picked up soon. Since this is the November issue — happy thanksgiving — and Cherrio! — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

27

Edward Durrell Stone, who died on August 6, was a member of our class by virtue of his studies in architecture at MIT after his graduation from the University of Arkansas. He was one of the world's most renowned architects, with his work ranging from the decorative U.S. Embassy in New Delhi, India, and the John F. Kennedy Center in Washington, D.C., to the more utilitarian — but nonetheless handsome — General Motors Building opposite the Plaza in New York. His work also includes the New York Museum of Modern Art (with Philip L. Goodwin), the Huntington Hartford Gallery in New York, and many schools, hospitals, churches, hotels, a synagogue, a mosque in Pakistan. He leaves his widow, Violet Campbell Stone, a daughter, and three sons.

Andrew Canzanelli, who died on August 7 at his home in Buzzard's Bay, was a civil engineer whose work included two bridges over the Charles River — the Weeks footbridge and the Cottage Farm Bridge (now known as the B.U. Bridge) — and the first shell built on the Charles River Esplanade for the Arthur Fiedler concerts. He came to M.I.T. after service as a first lieutenant in World War I and was a civil engineer with the Metropolitan District Commission in Boston until his retirement in 1955. He was a member of the American Society of Civil Engineers and a former editor of *Lines and Grades*, a Massachusetts state publication. He leaves a son, a daughter, and five grandchildren.

We still have a few people in the Reunion Picture who have not been identified. If you can help, please do; letters will be going out shortly to all those registered at the Alumni Day luncheon who have not yet been located in the picture. — **Joseph H. Melhado**, Secretary, 24 Rodney Road, Scarsdale, N.Y. 10583

28

We are most appreciative of the many complimentary letters and notes received from classmates who attended the 50th Reunion in June. It pleases us greatly to know that so many of you were able to attend and to enjoy that wonderful occasion. On behalf of the reunion committee, our thanks to all of you.

Some of the notes carried news bits and these we are happy to pass along, although they will have to be spread out over several months. **Shikao Ikehara**, who came the longest distance to be with us on campus, remained in the U.S. for nearly three months, thereafter traveling about and visiting with friends before returning to Japan. . . . **Lazar Gelin** was most happy to meet with many of his old friends during reunion week. Unfortunately, he was stricken with a severe case of shingles after arriving back home. At the time of this writing he was pretty well recovered. . . . Helen and **Bob Murphy**, on their way home to New York, stopped to visit with Bob's brothers in Providence, R.I. Bob also telephoned **Charlie Worthen** (who was unable to attend the reunion) and gave Charlie an early firsthand report on the event. Helen and Bob were very pleased thet **Eleanor Pepper** could accompany them on the trip to Cambridge. . . . Marian and **Jim McCarthy** were especially pleased with their 50-year class directory which has enabled them to locate again several of their past acquaintances. One of Mairan's friends fell in love with Marian's 1928 stole so Marian ordered one for her. There are still just a few left. . . . A note from Sue and **Jim Tully** tells us that Jim suffered a stroke in July but has been making a good recovery. They are glad that the misfortune did not strike before the reunion. The Tullys also report they had a pleasant visit recently by Ann and **Will Tibbetts**.

Phyllis and **Chuck Carter** wrote that they were pleased to see **Jim Cullen** recently and were glad to learn that his health was somewhat improved. Following the big week on campus the Carters spent a few days on the Maine Coast before returning home to Canada. In the early fall they plan to be in England for four weeks with London as headquarters. Relative to the reunion, Chuck wrote: "It was grand to see and talk to those whom I had not seen for so long and it reinforced my pride and appreciation for being a part of M.I.T.". . . From Marjorie and **Mac McDermott** we have: "We were particularly happy at the opportunity to meet and get better acquainted with so many classmates, some of whom we had never met before! It was a delightful experience." . . . In his note to us **Monte Burgess** writes: "On the occasion of our 50th Reunion, Blanche and I visited Building 10. On departure, I was asked by a new member of the Corporation if I would like to buy a chair. I said: "Yes, where is the Coop store?" He replied that he had reference to sponsoring a Huntington Hall Chair — a gift of $2,000. In the end I bought two chairs, one I took home in the Cadillac to sit on and the other for future use in Room 10-250."

We were delighted to receive a formal announcement of the marriage of Pauline Demond Fowler and **Edgar William Pitt**. The wedding took place on September 2 in Gilford, N.H. Ed and Pauline will be at home in Boca Raton, Fla., after October 15. We all wish them much happiness. . . . A note from Lillian and **Tom Larson** says that they will visit their daughter and her family in Ann Arbor, Mich., before proceeding to Lake Worth,

Fla., for the winter. They hope to meet with other '28ers at the M.I.T. Club of Palm Beach County. . . . A beautifully prepared and informative paper entitled, "1928 — The Last of the Great Years," has been written by Carole Joyce Davis, daughter of Marjorie and **Bill Bendz**. Coming at this appropriate time, Carole's review of life as it was fifty years ago is bound to stir nostalgia in the hearts of many. The paper is too long to present in these notes but we hope to find some way to have it distributed to you.

Miriam (Mrs. **Gerald S.**) **Brickett** writes that, prior to his death last May, Gerry had been chairman of their county library board and helped with the planning of a new library. Now the building is rising in the center of town and will be something visible to live after Gerry. Miriam plans to go on a Smithsonian tour of Japan in November. . . . Judith (Mrs. **Benjamin F.**) **Miller** was hostess at a reception held September 14 at the Francis A. Countway Library of Medicine in Boston when the Boston Medical Library celebrated the publication of Ben's book: "Poems — Partly Medical." In addition to being a widely known and respected medical doctor in his lifetime, Ben was an exceptionally gifted poet.

In the previous issue we reported briefly on the death of **Richard B. Rubin**. Dick was our class treasurer and, with wife Edythe, had worked closely with us and other members of the reunion committee. On August 12 Dick went to his office. (A friend stopped in to visit and found that Dick had collapsed. An aneurysm was the reported cause. Representatives of the Institute and members of the Class attended the beautiful and touching service for Dick. To Edythe and to her family we extend our heartfelt sympathy. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

29

James C. Reddig sends this note: "I was obliged to go to Europe last month. (It isn't a good year for traveling abroad at present exchange rates, so my airline accomodations were most modest. Before I left for home, I learned that my children had gotten together and switched my reservations so that I would ride home aboard the *Concorde*. The thrill is in one's head; the cabin environments give no feeling of traveling at an altitude of 57,000 ft, faster than twice the speed of sound. A brilliant technological achievement."

Clayton F. Jarvis, who lives not far from your secretary, spends his retirement in an ideal way! He winters in Florida and spends the rest of the year in Amesbury, Mass. He writes: "I feel resonably well after my open heart surgery a few years ago. I don't seem to have the same pep and the stamina for things as before. Maybe old age is catching up with me."

Seymour A. Baum, who is still active as president of B.H. Aircraft Co., Inc., of Farmingdale, N.Y., has responded to my birthday greetings: "It was most kind of you to remember me and I appreciate your thoughtfulness. I am still at the same old stand. Claire and I manage to keep the ball rolling." . . . **John Happel** writes: "We will try to make the 50th. I am hard at work in energy-related research at Columbia University and in a small company I organized. We had a short vacation in Grenada and Dominica in the Caribbean. I expect to go to a catalysis conference this fall after our usual summer at Lake Placid." . . . **Wilfred J. Danziger** took an early retirement in 1970 and is living quietly with his wife Hanna. I haven't seen Wilfred since graduation time, but his name echos in my mind from time to time, remembering the roll calls at Military Science — his name just preceeding mine.

Arnold S. Wood writes, "We have had the same routine for the past 15 years, living in New Hampshire from May to December and rest of the time on the west coast of Florida. I play some golf, enjoy a reasonably paced social life, swim in the Gulf when it warms up, visit the local good restuarants and relax with evening cocktails. We lead a simple but enjoyable life." . . . **Louis F. Southerland**, who is a senior partner in the architectural firm of Page, Southerland and Page, offices in Austin, Dallas, Houston and Corpus Christi, Tex., is planning to retire in 1979 and join us all at our 50th Reunion at Chatham Bars Inn at the Cape.

Al Moore writes, "Thanks for your birthday card even though it reminds me that I am a year older and in my 70s since the last one I received. I retired some years ago, like most of our classmates, and live a simple life at Rockville Center, N.Y., where I maintain an apartment. I have lived here about for the past 40 years. This serves me as a base to do some traveling and entertain friends and relatives when they visit New York. I am looking forward to our forthcoming 50th Reunion where we will all meet again. . . . **Walter H. Winchell** writes, "Now that I have reached the magic age of 72, I feel that I can afford to work only three days a week and do as I please the rest of the time (subject to my wife's wishes.) This gives me time to ride around on my bicycle, which I enjoy greatly, and take four-day-week-end automobile trips."

As you know, time is cruel, and as such it has taken its toll of our members. Among those recently deceased are: **Rudolph D. Wisbrun**, El Paso, Tex., on February 18, 1978; **Howard B. Hutchinson**, Sunnyvale, Calif., on May 13, 1978; **Carl W. Harris**, Long Boat Key, Fla., on April 30, 1978; **Herman J. Behrens**, Tenafly, N.J., on January 16, 1978; and **Harcourt C. "Ace" Vernon**, Wilmington, Del., on July 3, 1978. A note from his widow states, "Harcourt, 'Ace,' was looking forward to his 50th Reunion. I am sure he was disappointed not having been able to be with you." Even in such sadness, Mrs. Vernon kept her sense of humor by putting his present address as "Heaven" and his job status as "Engineer for St. Peter." Harcourt was associated with the DuPont Co. as a chemical engineer for many years. He retired in 1972, as associate director of engineering technology and materials research. He joined DuPont shortly after graduation. During World War II, he worked on the U.S. government's atomic energy program at Columbia University. He was the chairman of the board of the Mt. Cuba observatory from its inception in 1957 until 1972. He was a sports car enthusiast and the founding president of Wilmington Automotive Activities." Carl (Harris) was the chief engineer for the Public Utilities Commission for District of Columbia until 1942 when he entered the Army, joining the Corps of Engineers, seeing action in North Africa and Italy.

Only six short months to our Big Event at Chatham Bars Inn. Plan to be with us. You will enjoy it! — **Karnig S. Dinjian**, Secretary, 10 Ancient Highway, Plaice Cove, Hampton, N.H. 03842 (603) 926-5363

30

As previously reported in the notes, **Jack Latham**, about five years ago and at an age when many of our classmates were retiring, formed a new business enterprise known as Haemonetics Corp., of which he is the very active Board Chariman. Haemonetics manufactures blood processing systems and disposable plastic sets which are discarded after use on one blood donor or recipient. Haemonetics equipment extracts large quantities of platelets and white cells from the blood of one donor in support of one patient, often a family member; other devices recover red blood cells during surgical operations, and remove diluents, anti-coagulants and debris very quickly so that red blood corpuscles can be re-infused, even during the course of an operation or immediately thereafter. Still other equipment extracts quantities (three liters) of a very sick patient's plasma so that it can be replaced with healthy plasma or a purified fraction of plasma, or removes glycerol when retrieving red cells from long-term storage at low temperature (-80°C.). The Haemonetics systems are in active use throughout the world. Jack says the company's growth has been too rapid for comfort and leaves him little time for cruising, presumably on his ketch *Palometa*. . . . **Jean Kresser** is still active as a consultant in the field of electrical power systems for both industry and electrical utilities. Most of his work is with engineering construction firms on large industrial projects. . . . We have at hand a clipping from the Biddeford, Me., *Journal Tribune* reporting that the paintings and drawings of Mildred and **Ed Giroux** were on display in Waterboro, Me., last June. Ed's drawings are in water color and pen and ink and Mildred works in water color and oils. Both are active in the Regional Artisans League of Maine.

Jim Morton has retired from Loomis-Sayles and he and Muriel have moved to Siesta Key near Sarasota, Fla. They came north for a six-week vacation on Cape Cod last summer. . . . Ruth and **Irving Dow** moved to Leisure World in Silver Spring, Md., in September, 1976. Irving finds it very pleasant to be free from responsibility for grass cutting, outside painting and snow removal. He has been active in the Kiwanis and Camera Clubs and also serves on an administrative committee concerned with establishing the power rates for new condominiums as they are built. Irving says that there are now 2,400 housing units with a total population of 3,200 at Leisure World.

Irving's report includes the news that **Charlie Flint** died on September 11. Irving and Charlie both graduated in Course VI-A and went to work for the Bell System in New York. Shortly thereafter Charlie married one of Irving's second cousins who was attending Barnard College at the time. Charlie worked with the New York Telephone Co. in New York City until his retirement two years ago. . . . We also have at hand a notice concerning the death of **Ed Jenkins** on July 12, but no details are given. The last report I had from him dates from 1962, when he retired from Johns Manville where he had worked continuously since graduation. At the time of his retirement he was wood products section chief at the Research and Engineering Center in Manville, N.J. He was a member of A.S.C.E., the Insulating Board Institute, and TAPPI, and had taken numerous patents on Johns Manville products. He was also at one time president of the Bridgewater, N.J., Township Civic Assoc., a member of the School Advisory Board, a member of the Township Committee, the Planning and Zoning Board, the Building Committee, and the Mayor's Committee on Roads. After his retirement he did a certain amount of consulting work in the building materials field. He was living in Bridgewater, N.J. at the time of his death. — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

31

As you may know by this time, the news is out that our Mini-Reunion will be in Bermuda: Friday, April 26, to Tuesday, May 1. Polly and **Ken Germeshausen** have arranged for us to spend our time on the island where we can relax, play golf and tennis, go on a fish tour, and shop as well as renew old friendships and make plans for our big 50th. If you don't already have the information details and want them, drop a note to Mrs. Kenneth Germeshausen, 240 Highland St., Weston, Mass 02193.

A note from the **Eliot Grahams** reports they are alive and kicking. More news is promised at a later date. . . . After living alone, climbing the walls and becoming practically a hermit, yours truly decided to marry again. Her name is Helen and she has known me for over 35 years so she knew what she was getting into.

Sadly, we report the deaths of **Arthur Fitzgerald** at Mt. Auburn Hospital, Cambridge, on July 1; and Colonel **Wallace E. Niles** on December 22, 1977. Arthur Fitzgerald was vice president for academic affairs and dean of the faculty at Northeastern until his retirement in 1976. Our deepest sympathy to their families. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, Fla. 32757; **Ben Steverman**, 260 Morrison Dr., Pittsburgh, Penn. 15216; and **John R. Swanton**, 27 George St., Newton, Mass. 02158

32

Dr. **F. R. Morral** recently returned from a family emergency trip to Barcelona. Naturally he met with **Juan Serrallach** there. Who doesn't? . . . Marjorie and **Wendell Bearce** proudly announce they attended the high school graduation of their first grandchild. The son of their oldest daughter Anne, graduated with honors from the Christian School at Laconia, N.H. (There are seven more to follow.). . . **Ed Burritt, Jr.**, and his wife are planning an extended trip this fall. He hopes to visit with some of his classmates.

Louis E. Jones celebrated retirement last year by spending seven pleasurable months in beautiful England on the channel coast in East Sussex. Part of June was spent walking and mountain climbing in Scotland. In October he and his wife did the same thing in the mountains of Wales and the rugged coast of Cornwall. This was their seventh trip to England and they were not anxious to return to the U.S. However, their children and eight grand-children wanted them back for Christmas.

Jim Harper is happy to report his wife has passed the magic five-year period after her stomach operation in December, 1972. However, he feels that his Parkinson's disease has made some inroads with him. He no longer feels he can travel alone. Jim is a good correspondent, and he gives me quite a bit of information about classmates.

He tells me **Donald A. Rice** of Odenton, Md., still pursues sailing as a hobby. Donald says it takes him back to his many years of ocean traveling when he was with the U.S. Coast and Geodetic Survey. Jim also says that **Henry E. Worcester** of Annapolis, Md., is still an active horseracer and can often be found at the racetracks urging on his own steeds. In his spare time he operates a string of dry cleaning plants in Maryland.

Dr. **Howard M. Quigley**, Washington, D.C., retired in 1977 from his dedicated career in aiding communication with the deaf, particularly at Gallaudet College. . . . **Robert W. West**, Silver Spring, Md., and his wife made their annual trip in August to their second home in Maine. Bob is still an avid sailor, sings in his church choir, and in recent years has become proficient on the guitar, which he will soon play in a concert.

It is with sadness that we report that **Ebed L. Ripley** died unexpectedly after suffering a heart attack on April 1, 1978. He had been employed for many years as insurance underwriter for Liberty Mutual Co. A few years ago he retired to Brattleboro, Vt. He is survived by his wife Louise and his daughter Alice.

Also we learn that **William H. Duffy** of Weymouth, Mass., has passed on. He had been a metallurgical engineer for the United States Government at Watertown Arsenal. As an Army veteran of World War II he had worked on the Manhattan Project that led to development of the atomic bomb. He leaves his wife, Mary, and two daughters. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass. 01907

33

Our genial President gets the banner headlines this time around, for one great big reason; he is a real go-getter. Even before the late reunion was over he announced a 50th-Reunion meeting before the end of summer, to lay the groundwork for the celebration in 1983. We had that meeting September 11th, and it was attended by **Ellis Littmann**, **Warren Henderson**, **Fred Murphy**, **George Stoll**, and **Westy Westaway**, plus Joe Martori and Mary Kyger of the Alumni Office. Rather than report the meeting, I asked Ellis to send me a report to be used in the notes:

"The Class of 1933 is off to a good start in its plan for the next five years and the 50th Reunion in 1983. The class officers have already met and are developing the Reunion team, and we will send out notices of this promptly. The enthusiasm from our 45th Reunion was wonderful, and it is our intention to maintain that enthusiasm and have an equally successful and, indeed, an even better and larger reunion at our 50th."

Now for a few (very few) personal comments. We have a fine note from **Jack Andrews**. He has and has had a lot of enthusiasm for our 45th and praise for the committee. . . . I wrote **Guido Garbarino**, and Mary wrote back that Guido was in Liberia for some weeks. . . . We had a fine note from **Bill Baur** right after the 45th, with again great praise for the committee. Bill visited family for a week or so following the reunion before going back to Dunedin, Fla. Very shortly afterwards, his wife Claire suffered a massive brain hemorrhage and died instantly. Bill has been my close friend since we were both sophomores, and I know that I speak for our Class when I offer him our kindest sympathy. Bill is active in alumni affairs, his most important job being Secretary of the Central Florida M.I.T. Club.

I have a copy of a letter to Ellis Littmann from **Cy Hapgood**, who tells us that he is happy to continue as Class Estate Secretary. Cy proved his dedication to his Class and the Institute by coming over from New York on a very miserable day to attend our class officers meeting.

We have a couple of press releases: **Morris Cohen** makes it again; he is announced as the Alpha Sigma Nu Lecturer at the November meeting of the American Society for Metals in Philadelphia. Morris is a Fellow and Past President of A.S.M. In the same category, we have another who has been honored many, many times. **Donald G. Fink**, who was awarded the I.E.E.E. 1978 Founders Medal with a suitable and laudatory citation. Don is an Emeritus Life Member of the I.E.E.E. Board of Directors, this awarded to him on his earlier retirement. Still another of us has been recognized as outstanding in his area: **Dick Morse** was invited to testify for "small business" to a joint meeting of the House and Senate Small Business Committee. Dick is now retired after 15 years as Senior Lecturer in the Sloan School.

Ivan Getting, another of our greats, has been elected a member of the Board of Directors of the Northrup Co. of Century City, Calif. You will recall that Ivan retired as President of Aerospace over a year ago, and he has been president of I.E.E.E.

Beau Whitton sends me a copy of a letter to the M.I.T. Historical Collections, to which he attached a detailed account of the film he showed at the 45th. I won't attempt to enlarge on that, but I do think that Beau was asking me to call your attention to the fact that M.I.T. does have such an historical effort. We all are asked to preserve photos and all such for this collection, and present them to Warren Seamans in this office. I have a 16-mm. film, 400 feet, taken at the Fifth Reunion, and possibly some of the 25th, which I want to show at the 50th, and will thereafter deposit them with the Historical Collections.

From Alumni Fund envelopes we find that **Bob Keyser** has finally retired and was then on an extended trip south on his own boat, "Hal V." **Dave Nason**, from Cape Cod, writes that he is retired as of 1975 and spends his time gardening, travelling, and baiting public officials.

We have the usual brief note from **Walt Skees**; this time he sends a postcard from Spain, and on the obverse is a picture and recipe for Paella, one of my favorites when I am where I can get it. Thanks, Walt.

Far too many of our classmates have passed away since our last appearance. Professor **Francis T. Hall** died in June. He was a Professor of Electrical Engineering, retired, and lived on the Cape. **Benjamin C. Hiatt** passed away in May; he, too, was an electrical engineer, though I have nothing further. Professor **Howard H. Langdon**, of Macedon, N.Y. passed away in January, 1978. I did know Howard as a student, as he was a mechanical engineer, though I cannot recall seeing him since. **Edward L. Meehan** of Bethesda, Md., passed away in June, 1978. **Edward S. Quinlan** died in March, 1978; he was an electrical engineer, lived in Las Cruces, N.M. **Richard H. Shepp**, of Kilmarnock, Va., died in March, 1977. And I have a clipping from a Portland, Maine, paper informing us that **Harold W. Russell**, of Albany, Calif., passed away in February, 1978; Harold did graduate work at M.I.T. but took his

How to Give New Wings to the Spirit of Entrepreneurship

Though "the spirit of entrepreneurship is still alive and healthy," the U.S. has lost "our once-unique position as an innovative industrial society," says Richard S. Morse, '33, founder and former President of National Research Corp. who retired two years ago as Senior Lecturer in the M.I.T. Sloan School of Management.

"High-technology products made a major contribution to our exports and are essential if we are to solve our current critical balance-of-payments problem and the declining value of the dollar," Mr. Morse said in testimony to the Joint Small Business Committees of the Senate and House of Representatives late last summer.

But in the last decade, he said, "almost every action taken by the Executive and Legislative Branches of our government has resulted in . . . deterioration in the climate for technoligical innovation in the U.S." Among these changes:

—Financial incentives for both investor and entrepreneur have been "greatly reduced" by "the very substantial reduction in the gap between personal income and capital gains taxes."

—The "principal mechanism used by small companies to attract and hold key personnel" — the so-called employee qualified stock option — has been eliminated.

—Government in-house laboratories as well as federally funded nonprofit research organizations now compete for research funds with small, high technology companies which have traditionally been the sources of invention and new products.

—Bureaucratic government regulations affecting proposal-writing, accounting, auditing, and reporting have significant impact on smaller companies with limited resources, and these are the very companies from which new products are most likely to come.

—Increased interest rates and inflation have reduced incentives for corporate investments in new high-risk, high-technology research programs. As a result there is increased emphasis on short-term return as an investment criterion.

Concluding his warning, Mr. Morse called on Congress "to recreate a national environment so that . . . our small, innovative high-technology companies can flourish and new enterprises can be generated. With proper incentives for management, entrepreneurs, and inventors, we can again create great industries for the future," he said.

*Paul H. Robbins, S.M.'36, retired last summer after 32 years as Executive Director of the National Society of Professional Engineers in Washington. Through this whole period, writes Milton F. Lunch, N.S.P.E.'s General Counsel, in a special issue of the Society's magazine (*cover, above*), Mr. Robbins worked consistently to fulfill "the idea that the engineering profession could be identified and then gain its full status as an influential force in the affairs of the nation." Mr Robbins was the author of the creed (right) adopted by the N.S.P.E. in June, 1954.*

Engineers' Creed

As a Professional Engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.

I pledge:
To give the utmost of performance;
To participate in none but honest enterprise;
To live and work according to the laws of man and the highest standards of professional conduct;
To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations.
In humility and with need for Divine Guidance, I make this pledge.

Paul Robbins Retires: a National Voice for Engineering in Washington

The Washington community of professional society professionals lost one of its pioneering members last summer when Paul H. Robbins, S.M.'36, retired as Executive Director of the National Society of Professional Engineers. He had held the job for 32 years, ever since leaving the Army Transportation Corps at the end of World War II.

In his salute on Mr. Robbins' retirement, John T. Kane, Editor of *Professional Engineer*, says Mr. Robbins' "involvement in the non-technical aspects of engineering as a profession is unmatched.

"His career spans the universe of engineering society activity and the growth of engineering professionalism from the end of World War II to the present," writes Mr. Kane. It includes White House visits with every U.S. President from Truman to Carter, testimony before innumerable Congressional committees, talk with federal officials on every aspect of engineering practice and technology policy, and meetings with engineers and their societies "on virtually every topic of interest to the engineering community."

When Mr. Robbins was chosen for his N.S.P.E. assignment in 1946, the Society was little more than a loose federation of state organizations whose membership was about 12,000. But there was "a legacy of high aspirations for a multidiscipline, national society built around the concept of engineering as a profession," and Mr. Robbins set out to fulfill it.

He did.

By 1947 membership had gone to 17,000 — a 60 per cent increase in just over a year; today it's 76,000. A staff of nine has grown to 70, occupying its own headquarters building now valued at $1.5 million. And Mr. Robbins himself and the N.S.P.E. which he led, has become familiar throughout the Washington scene as spokesman for engineering and advocate of the profession's contributions.

"Through sheer persistence and a mastery of the group dynamics of meetings," writes Mr. Kane, "Mr. Robbins pushed and pulled N.S.P.E.'s 'presence' into virtually every nontechnical issue debated and discussed over the past two decades." Thanks to his leadership, N.S.P.E. is beginning to fulfill its aspirations as a "center of the action" for all engineers and their interests in the nation's capital.

bachelor's at Lowell Textile Institute (now a University). Technically, this should have been sent to the Graduate Class Secretary, who also publishes a column. I wish to report in no detail that I missed sending in copy last time around, due to an illness that was embarrassing in that respect. Inasmuch as I am healthy again, the onus is back on you fellas to get the copy in, as the Editor frowns on my inventing subject matter.

That's all for now, fellas and gals. Leona joins me in sending each and all of you a wish for a merry Christmas and a very happy and prosperous new year. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, N.H. 03800

34

Once more, unfortunately, this is a column that should be set almost entirely with black borders around. For I have to report the loss of five more classmates; ironically, the information on three of them comes as a result of **Carl Wilson**'s letter about next year's reunion.

Stanley Bebler had spent all of his career as a naval architect working with a number of shipyards, but from 1957 through 1975 he had been with Friede and Goldman, Inc., of New Orleans. He may have retired, as his final address was Pass Christian, Miss.

C. Bradford Dean had spent many years in structural design work at Jackson and Moreland, including some work on water systems in Puerto Rico. He served in the Navy during World War II and achieved the rank of Lieutenant Commander. As of 1975 he was retired and living in Charleston, S.C., but his last address was shown as Fort Plain, N.H., so he may have moved north again.

F.S. Ko had returned to the Orient and both in 1959 and 1975 he was listed as the Managing Director of the Tak Shing Investment Co., Ltd., in Hong Kong.

Samuel Rulon I remember from school, and — while he worked for some years in the chemical engineering field — since 1949 he had devoted himself to theatrical work. He was not only a playwright but also worked in the managerial and production end of touring companies and for several summer theatres in the northeast. At the time of his death he was the manager of the Grendels Lair Cafe Theatre in Philadelphia.

Finally, to conclude this sad litany is a name that will be familiar to anyone who has attended our reunions — **Charles T. Stewart**, who died only June 21 of this year. Charles apparently devoted his entire career to the glass industry. He had controlled the Glapat Corp. since 1940 and in 1945 organized the Stewart Manufacturing Co. to make Glapat glass machines. These two companies were combined in 1949 and the business also expanded into material handling machines. He was presumably still active in the company at the time of his death.

On behalf of all our classmates, I would express our sympathy and condolence to the surviving members of the families.

On a pleasanter note, *Down East* Magazine for July had quite an article about **William Milliken**. While still at the University of Maine he started working on a homemade airplane — apparently the first such in the state of Maine that actually flew. Bill worked on it from 1927 to 1933, by which time he was studying aerodynamics at M.I.T. In 1933 he actually got his plane into the air at Old Orchard Beach, but it flipped over on landing. So it went into his mother's barn in Old Town. But Bill himself was undaunted and went on into the aircraft industry. In World War II he was Assistant Chief of Flight Test for Boeing Aircraft; then he went on to the Flight Research Department at Curtiss D. Wright and stayed when it became the Cornell Aeronautical Laboratory. By 1959 Bill was Director of the Laboratory's Full-Scale Division. However, along the way his interests began to switch to racing cars, and he competed in many well known races. He is still living in the Williamsville, N.Y., area, but the interesting end to the story is that the plane survived in the barn in Old Town and in September, 1977, Bill presented it to the Owls Head Transportation Museum at the

Knox County Airport near Rockland, Me. It's on exhibition and being restored, along with other vintage aircraft. It did fly once — forty-five years ago on September 5, 1933.

These notes were held up so I could pass on some news about how things were progressing toward our 45th. So far, about 100 have responded with class dues; about 60 have indicated they were planning to come, and another 38 were hoping to make it. Much in the program plans will be of interest to women, and the next mailing in January will outline the options. (For example, are you interested in Tech Night at the Pops, Technology Day, and the reunion week-end, or just the latter?) As you will see, we're planning a nice balance between time around M.I.T. and some visiting around the highlights of the new Boston. — **Robert M. Franklin**, Secretary, 620 Satucket Rd., (P.O. Box 1147), Brewster, Mass. 02631; **George G. Bull**, Assistant Secretary, 4601N Park Ave., Apt 711, Chevy Chase, Md. 20015

35

Here's some news from **Frank Hatch** in Burlingame, Calif.: "I'm keeping busy with all kinds of unpaid activities such as secretary of the Rotary Club of San Mateo, director and editor of the newsletter of our local A.S.M.E. section, taking care of the yard, making wine from California grapes, etc. Maybe next year I can get to the Boston area in June when the class mini-reunion is held. Our younger daughter's husband is Air Force aide to President Carter, and they live in Maryland not far from Washington."

Goff Benson writes from Pound Ridge, N.Y., "We took the Quarter Century Club 'Fabulous Scandinavia' trip in June. Great trip but no one else from M.I.T. — mostly B.U.; fortunately only 16 in total. When we got back we were invited by a neighbor to share his boat on a two week cruise to Cape Cod and the islands. Next week we are going to Minnesota to see my 92-year-old father and then expect to stay home the rest of the summer."

The 18th Annual Class Golf Tournament is coming down to the wire. Winners have been set in three of the flights and the fourth one is delayed only because of the failure of our postal service. **Bill Bates** won the Grey Flight, **Bill Cross** the Grey Flight Consolation, and **Ellis Flink** the Cardinal Flight Consolation. **Ned Collins** and Goffe Benson are the opponents in the Cardinal Flight; the winner will play Bill Cross. In the other half Bill Bates plays Ellis Flink. Winners of those matches meet to determine the Class Champion for 1978 and holder of the President's Trophy for a year. If Bill Bates prevails he will retire the trophy as he already has two legs on it.

I am sorry to have to report to you the deaths of two more of our classmates; **Darrell A. Root** on August 2, and **Edmund L. Gregor** on July 7. Darrell retired in 1976 as Senior Vice President of Camp, Dresser and McKee, Inc., environmental consulting engineers in Boston, with whom he had been 28 years. At the time of his death he lived in North Andover although he had lived for many years in Winchester where I used to see him occasionally. Ed Gregor and Maggie were living in Florida after Ed's retirement from his New Jersey business, and they spent their summers in Maine. Rhoda and **Bernie Nelson** visited the Gregors on their trip through Florida last year and travelled to Maine to see Maggie in September. The Nelsons also hope to check out a couple of places for our 45th. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

38

Horace H. Homer has been named a senior scientist for the G.T.E. Lighting Group, a part of General Telephone and Electronics Corp. Horace, who had been an engineering specialist, serves as a consultant on chemical operations and processes at the Sylvania Lighting Center in Danvers. . . . **Ascher Shapiro** has the answer for the housewife who is confronted with a recipe for a number of servings different than the number of servings she desires to prepare — especially if she hates mathematics. Answer: buy her Ascher's recently patented recipe-conversion calculator. It will also convert foreign units of measure into familiar units. (This is 1938's suggestion for Christmas giving.)

Eric Reissner, professor of engineering at the University of California in San Diego was honored recently on his 65th birthday at a symposium and banquet. Eric holds a joint appointment in the Department of Applied Mechanics and Engineering Sciences and the Department of Mathematics. He is noted for his work in mechanics and applied mathematics, particularly in the fields of elasticity and shell theory.

Bob Flynn passed away in August. For a number of years he had been a partner in the New York law firm of Flynn and Frishauf. — **A L Bruneau, Jr.**, Secretary, 412 Ponfield Place, Ridgewood, N.J. 07450

39

John Renshaw was elected Director of the American Council for Capital Formation. John is President of Van Strum and Towne, Inc. and he directs its activities in investments advising. . . . **Art Zeldin** received special attention for his achievements to make the air in Salt Lake Valley cleaner, clearer, and healthier. Several Utah newspapers reported specifics about the $250-million project Art managed for four years on behalf of Kennecott Copper Corp. Congratulations, Art! Our Country needs more of what you have done. . . . **Solomon Baker** was elected Vice President of Rogers Corp. and he has become responsible for both the Poron and Fiberalloys Divisions. During 1949 Solomon founded Temple Beth Israel in Daniels, Conn., and he now serves on its Board of Directors and on the National Executive Committee of the American Jewish Congress.

Louis S. Castleman and **Fred Holloway** were elected to fellowship in the A.A.A.S. . . . **Burt Rudnick** is developing industrial and commercial real estate in the greater Boston area. . . . Professor Sir **William R. Hawthorne** was recognized by the M.I.T. Quarter Century Club on his retirement. . . . **Billie and George Cremer** wrote from 33,000 ft. over Iceland as they started travel adventures scheduled to last for the next year or so on the Continent. They'd like to receive and answer correspondence c/o Richard Applebee, 7 Green St., Purley, England.

We were saddened by the death of **James Lampert** whose distinguished career included achievements as Lieutenant General of the U.S. Army, and Superintendent of West Point.

Also, we must report the death of **Chester A. Williams** of West Yarmouth and North Weymouth. Chester was a member of the Purple Heart Association and he had retired from Stone and Webster, Inc.

Harold Pope earned special recognition with his appointment to Chairman of the Board of Directors of Sanders Associates, Inc. . . . . **Jim Barton** and Mary are about to face hardship again. This time they are required to leave their lovely estate on the shores of Lake Washington for a month of international travels which include Athens. And wouldn't you know that just about now the Pacific Northwest has rains, and in Greece the year's best weather is approaching!

John Alexander has joined a group which might become known as "39ers At Sea." From undergraduate days we all remember John as captain of our Lacrosse team. After graduation John's career and mine overlapped because we both played tuba and sang with S.P.E.B.S.Q.S.A. which is a U.S.A. society of 38,000 dues-paying members who meet each week to create harmonies in the barbershop style. However John's major career has been in Seattle with Boeing, and he retired recently. Before retirement, John and his pretty wife, Nancy, added sailing to their tuba playing and barbershop singing hobbies. Then, on retirement, John and Nancy announced they would sail their 41-foot ketch, named *Polaris-41* and designated "CT-41" to the South Pacific.

John Renshaw, '39

In due course there were bon-voyage parties at the famous Seattle yacht clubs. Classmates in attendance included the **Hans Bebie**s and the **Holden Withington**s and the **James Barton**s, and also the Nils Rosenbergs ('40).

After the Seattle ceremonies John and Nancy sailed away, assisted by crewman Keith Barton who, by the way, is the handsome son of Mary and **Jim Barton**. It turned out that, en route from Seattle to San Francisco, Mother Nature challenged them with gales that blew at 60-plus knots for two days.

At this writing the sailors are in the San Francisco area planning their future courses. Part of the plan includes daughter Janie Alexander who will continue her nursing in Seattle until the last moment, then fly to join the others at Dana Point in California. Then this foursome will set sail to Bali Bali and other glamorous South Pacific destinations.

If we can conquer high winds and high waves and tenuous communications you'll be reading more about "39ers At Sea" in these notes.

In the meantime and back at the ranch, there are a few of us stay-at-homes who like to know what *all* of our classmates are doing and we have an intense interest in that. So, why not sit down this minute to respond to this need of our classmates? — **Hal Seykota**, Secretary, 1421 Calle Altrua, La Jolla, Calif. 92037 [Phone: (714) 454-2009]

40

Our Sad Duty. **James S. Rumsey**, President of the Class of 1940, died in Wilmington on August 14. His untimely death came as plans for the 40th reunion were beginning to form. We shall miss his enthusiasm and his dedication to M.I.T.

At the Helm. **N. Bruce Duffett**, a name familiar to '40 alumni from his work with the annual alumni fund drive, moves from his post as Vice President to the vacancy left by Jim Rumsey. As our new President, Bruce has announced that **Norman R. Klivans** and **H. Garrett Wright** will serve as Vice Presidents. **Frank A. Yett** continues as Secretary-Treasurer; this double job may have to be separated as . . .

The Pace Quickens. Bruce is already prepared for the year of activity leading to our reunion in June of 1980. He envisions a "happening" that will make a lasting impression on the Class and M.I.T. In addition, he is planning the Class of 1940 Gift to M.I.T. on the occasion of our reunion. Bruce welcomes your reactions and this column is open to everyone's opinions and suggestions.

Next Year, Jerusalem — Almost. The Council for International Exchange of Scholars has announced that **Martin A. Abkowitz**, professor of ocean engineering at M.I.T., (and always the first name on our class roster) will be at Technion—Israel Institute of Technology from January to June, 1979. — **Frank A. Yett**, Secretary P.O. Box 562, Long Beach, Wash. 98631

42

Joe Boltinghouse is still at Autonetics Strategic Systems Division of Rockewell International in Anaheim, Calif., where he is designing gyro-

A rejuvenated M.I.T. Club of New Haven, Conn., featured Jerry Wiesner, President of M.I.T., as the speaker for it's spring "kick-off" meeting last May. Newly elected officers for the club are (left to right) Jonas C. Kjellberg, '53, President of Saab-Scandia of America, Inc. (Treasurer); William B. Maley, '48, Chairman, Translite, Inc. (Vice President, Membership); David W. Chaffin, '50, President of Applied Data Processing, Inc. (Vice President, Programs); Jerome B. Wiesner and Walter L. Wise, Jr., '34, Chairman, The Henry G. Thompson Co. (President). The Secretary, John B. Gardner, '44, was unable to attend.

scopes for inertial navagation systems. . . . **Walt Robbie** has joined Towle Silversmiths as Vice President—Corporate Manufacturing. . . . **Jack Cantlin** was recently appointed Executive Vice President of Hudson Lock, Inc. . . . **Marsh McGuire** has been promoted to Vice President — Product Research and Development for the Moore Company of Springfield, Mass. . . . Finally, **Stan Golembe** has been named Vice President and General Manager of Itek's Measurement Systems Division in Newton, Mass. And that is the end of good-paying promotions.

Now for nonpaying appointments and honors. **Al Clear**, who is President of the Stanley Works, has been elected one of the outside directors of Stanley Home Products, Inc. in Westfield, Mass. Stanley Home Products, of course, is in no way affiliated with the Stanley Works! . . . **Henry Hill**, who received his Ph.D. in Course V with our class, now has another doctorate — an honorary doctor of science degree from the University of Missouri. You may remember that Dr. Hill is the immediate past President of the American Chemical Society. Looks as though Course V graduates do pretty well. . . . Your secretary was elected Associate Treasurer and a member of the Board of Trustees of ARZA — the Association of Reform Zionists of America.

Lou Rosenblum writes that he and Sandy were cruising off the coast of Maine last summer and ran into **Dick Gobson** and his wife, Olive, who were hosts for the Blue Water Cruising Club which gathered at the Gibsons' waterfront blueberry patch and farm on Newberry Neck in upper Bluehill Bay. Dick retired from the Air Force about ten years ago and is Chairman of the Electrical Engineering Department at the University of Maine. The Rosenblums also met Ruth and **Bob Wagner** who were guests on Dick's boat.

Jack Flipse, formerly President of Deepsea Ventures, Inc., delivered himself of a typically blunt comment on deep sea mining recently: "The people who thought they would make money in it (deep sea mining) are disillusioned. . . . If you were a crap shooter, you'd get out of this game by now." Jack probably knows as much about deep sea mining as anyone in the business having developed most of the technology for Deepsea Ventures, a division of Tenneco. Actually the problem seems to be the stalemate on the Law of the Sea Treaty which, as it now stands, severely jeopardizes profits which may be made in this field. . . . One very high class retirement this year: **Lawrence Beckley**, who graduated with our class in Course XVI, has just retired from M.I.T.'s Center for Space Research after 36 years of service at the Institute. We wish him the very best of health and happiness in his retirement.

Unfortunately, our obits this month are on a global basis. **Bob Ely** passed away in Niantic, Conn., on September 3. Bob was well known in the Air Force as one of the first Army helicopter pilots. He piloted all kinds of brass during World War II, including Generals Mark Clark and Dwight D. Eisenhower. From Turkey, news that **Sabaheddin Fenmen** of Ankara and **Mehmed Kozak** of Istanbul have both passed away. We extend our sincerest sympathy and condolences to their families. — **Ken Rosett**, Secretary, 191 Albemark Rd., White Plains, N.Y. 10605

43

The news service forwarded to me a most inter esting article by **Jim Reswick** entitled, "Some Thoughts Relative to the Rehabilitation Engineer," which appeared in *The Bridge* (National Academy of Engineering) this past summer. His involvement and leadership in this specialized field has been recognized world-wide. Jim is Professor of Biomedical Engineering and Community Medicine at the University of Southern California and Director of the Rehabilitation Engineering Center at Rancho Los Amigos Hospital in Downey, Calif.

Professor **Richard Adler** has been appointed an associate head of the M.I.T. Department of Electrical Engineering and Computer Science, where he has been very active and outstanding during his teaching and research career. . . . We received word that **Vincent Bashore** passed away in Palmdale, Calif. last year.

I await with bated breath the financial report from the 35th Reunion treasurer, because, as many of you know, we took tha elastic band off the roll for this one. — **Richard M. Feingold**, Erstwhile Secretary, 799 Prospect Ave., West Hartford, Conn. 06105

44

Happy Thanksgiving Day! Although almost every culture and religion has accommodated man's urge to give thanks for the harvest, American's Thanksgiving Day is a very special holiday. (Canada had its Thanksgiving Day on the same day many of us celebrated Columbus Day: Monday, October 9.) The holiday must have meant even more during the Puritan ages when the celebration of Christmas was banned. Whether the Indians joined with the Pilgrims or not on that first Thanksgiving day in Plymouth, we inherit both the hope that they did and the guilt for their later treatment. Certainly it has become a family day, and in New England the Friday after has become a "visit Plymouth" day.

Robert L. Halfman, professor of aeronautics and astronautics and, since 1972, Associate Dean for Student Affairs at M.I.T. was named Acting Dean for Student Affairs effective September 1. His appointment comes at a time of reappraisal of the organization and structure of student support responsibilities. His classmates wish him success on these activities which can mean so much to the Institute and its students in years to come.

We note that the next issue (December-January) of Technology Review goes to press on December 29th. So, we wish to be the first to wish all of you a happy and joyous holiday season. — **Melissa** and **Newton Teixeira**, Co-Secretaries, 92 Webster Pk., West Newton, Mass. 02165

50

Donald J. Gray of Lynnfield, Mass., has been elected to Chairman of the Finance Committee in that town. Don is an electrical engineer at G.T.E. Sylvania Laboratory in Waltham, Mass.

We regret to announce the death of two of our classmates — **Walter A. Platt**, who died on February 23, 1978, and **Arthur C. Savoth**, who died on May 1, 1977. — **John T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

53

The 25th reunion has come and gone, a success on all counts. Somewhere between 100 and 200 attended (I did not count them personally, but I think I talked to more than a hundred.) The arrangements were superb and everything went off like clockwork, thanks to the outstanding efforts of the reunion committee and the Alumni Association Staff.

Durgin Park is still the same, but Scollay Square is all but non-existent. Arthur Fiedler is still conducting the Boston Pops and the alumni are still singing "Arise Ye Sons of M.I.T." The "Old Institute" has changed greatly. The trees behind Baker House that were planted when we were there are now a couple of feet in girth. The scene of the glove fight is now a well kept track and field complex. Walker Memorial is still there but the new Student Union is a tremendous improvement. High rise complexes dominate the West Campus and the West End Skyline.

The weather was rather forbidding while we were there, even providing a violent and noisy thunderstorm during the Technology Day Luncheon in Rockwell Cage. The cocktail party at the President's house was delightful, particularly in the beautiful garden. Seeing some students sitting on the back wall brought back old memories. Our excursion to George's Island and the clambake on Saturday could not have been better. Those

middle-aged 53ers even played softball, suffering only one dislocated shoulder.

The only negative occurence happened at the banquet on Friday evening. The nominating committee, working steadfastly to come up with a slate of officers, was unable to snag anyone for the job of Secretary. After suffering under undue influence (two broken arms and three toothpicks under fingernails), the undersigned was "persuaded" to accept the honor. Nevertheless, a good time was had by all.

There is quite a bit of news about our classmates, but don't let that stop you from sending news to me! The Coast Guard announced the June 20, 1978, promotion of Robert I. Price, Naval Engineer, to Vice Admiral with assignment as Commander, Coast Guard Atlantic Area. And here I'm only a retired Air Force Colonel. . . . Dr. **H. Daniel Stage** has been appointed Director of Loyola Marymount University's Graduate Program in Business Administration. He was in civil engineering at Tech and received his Masters and Doctors degrees from U.S.C. . . . My old friend, **Mark Schupack**, has been appointed as Brown University's Associate Dean of the Faculty and Academic Affairs. Mark was chairman of the Economics Department from 1969 to 1974 and most recently served as Secretary to the Brown Faculty. . . . **Bruce Murray**, Professor of Planetary Science and Director of the Jet Propulsion Laboratory, California Institute of Technology, was elected to membership in the American Academy of Arts and Sciences on May 3. Congratulations to all.

Remember to send me some news or I'll make some up. With seven kids, I could fill up volumes. If anyone comes to Washington, D.C., or vicinity, give me a call. — **Gil Gardner**, Secretary, 2400 Rusticway La., Falls Church, Va. 22044

54

When the frustrations of commuting, taxes, the job and modern everyday life get to us, we often dream of a simpler life on the beautiful coast of Maine, messing around with boats. We recently discovered that **Joel White** is living our fantasy. Joel, as owner of the Brooklin (Me.) Boat Yard, builds and repairs all manner of watercraft but prefers to work with wood. Down the coast a bit, Elaine and **Robert Dow** recently presented an historical sketch to the Thomaston (Me.) Historical Society. The Dows, who live in Topsfield, Mass., have been presenting sketches of this nature for five years. This entertaining, well researched program depicted the beginnings of public school education in the New England colonies. John, in costume, played the role of a stern old school master at a parents meeting with a convincing gruff repartee and wry humor.

Folks along the New England coast can thank **Allan Murphy** for our less-than-definite weather reports. Allan published a paper entitled "Hedging and the Mode of Expression of Weather Forecasts" in the *Bulletin of the American Meteorological Society.*

Bob Warshawer reports that work on our 25th reunion is progressing and that well over 100 classmates have indicated their intention to attend, including many from overseas. We appear headed for an all time class attendance record. — **E. David Howes, Jr.**, Secretary, Box 66, Carlisle, Mass. 01741

55

We haven't received a great deal of mail from you lately, and we wonder whether the Post Office has some difficulty delivering class news items or whether the class members have gone into a period of hibernation prior to the 25th Reunion. There are a few items here, but we could use more. **Frank E. Perkins**, head of the Department of Civil Engineering at M.I.T. since 1975, has been named chairman of the federal Dam Safety Independent Review Panel. Dr. Perkins is known for his work in developing computer applications for the fields of water resources engineering and hydrology. The panel will review the regulations, procedures and practices of federal agencies as they pertain to dam safety. The appointment was made by Dr. Frank Press, Director of the Office of Science and Technology Policy and science advisor to President Carter.

John Ackley, who has recently achieved semi-retired status on St. Thomas in the Virgin Islands, is active on 20 and 15 meter amateur radio. For those wishing to reach him, his call is WB2LZO/KV4. . . . **Gordon B. Pye** has been elected a senior vice president of the Irving Trust Co. He will manage the bank's Economic Research and Planning Division. Prior to joining Irving in 1974, he was an economic consultant for Standard Oil of California. He also has served on the teaching staff of the University of California at Berkeley for nine years, most recently as Professor of Business and Administration and Chairman of the Finance Department. He is a member of the Economic Advisory Committee of the American Bankers Association and is an associate editor of the Financial Analysts Journal.

Roger Reiss, who is an engineer at Stone and Webster, is designing items for his wife's jewelry store, Judith Carole Curio, which recently opened in the Faneuil Hall, South Market Arcade in Boston. The store is a family operation, with 18 year old Ronde Reiss as the manager. It is their second venture after opening six years ago in Newton. . . . **Roy M. Salzman** recently completed the Advanced Management Program at the Harvard Business School. He found it very stimulating, and is now back to consulting in management information systems planning with Arthur D. Little, Inc. . . . **Leonard R. Sugarman**, who has retired from active duty with the U.S.A.F., has assumed new duties as assistant to the Director of the Physical Science Laboratory at the New Mexico State University. His principal responsibilities will be short and long range planning, special studies, and public relations. — **Marc S. Gross**, 321 South Roxbury Dr., Beverly Hills, Calif, 90212; **Allan C. Schell**, 19 Wedgemere Ave., Winchester, Mass. 01890

57

I just received some news clippings reporting that **Guy Carbone** is running for the office of District Attorney in Middlesex County of Massachusetts. Guy is currently the senior counsel and prosecutor for the commonwealth's Department of Labor and Industries. One of the clippings provides the following additional biographical information: "He has taught structural engineering at Tufts University and at the Harvard Graduate School of Design. For nine years before he joined the Department of Labor and Industries he was the Chief Engineer for the Commission that supervised the design and construction of Boston's Government Center. Attorney Carbone has held political office in Watertown serving as a School Committeeman for four terms before being elected to the office of Selectman.

"Carbone is a Lieutenant Colonel in the Corps of Engineers, U.S.A.R., and is currently an instructor with the 1037th U.S.A.R. School in Boston where he teaches in the non-resident phase of the Command and General Staff College."

Last month I mentioned I would bring you up to date on my continually changing career. So briefly, here goes! After only 11 months as chief financial officer of the New York Health and Hospitals Corp., the organization that operates the city's 17 municipal hospitals, I left as a result of political maneuvering. I enjoyed the work enormously, and have never worked harder. My accomplishments were not appreciated, it turned out, so I resigned. I learned a tremendous amount, including the fact that I'm not a political animal. By the way, my successor is also an M.I.T. graduate, Ron Walter, '63. I wish him luck. He has had a rather substantial career in city government and will do a good job.

Within a few weeks of my resignation I accepted a fine offer to join the management of Shared Medical Systems Corp. S.M.S. is the largest provider of information services to hospitals in the United States. I am in charge of developing the international business for S.M.S. and now am actively working on major opportunities in Europe and Japan. (As I write these notes I'm flying from Copenhagen to Tokyo.)

Since S.M.S. is in King of Prussia, near Philadelphia, we've bought a small victorian house in Carversville, Bucks County, which I use when I'm in the U.S. (only one to two weeks a month) and we all use on weekends. Betty and our two younger children are staying for the present in New York where the children love P.S. 75, one of Manhattan's larger and better public schools, and Betty is heavily involved in work with handicapped children. Our older, adopted son, Raimo, who graduated from F.V.M. in June, is back in Finland working and fortunately off the dole!

We're still semi-attached to Holland, Betty's home country, and go there a few times each year. The old 17th century hunting lodge and farm we bought 11 years ago still remains a great source of enjoyment. Betty has developed the garden and we've added what we think is the ultimate luxury, a tennis court. So it's a hectic, changing life but a happy one. Until next month — **Fred L. Morefield**, Secretary, Aquetong Rd., Carversville, Pa. 18913

62

Peter G. Anderson announced he is Chairman of the newly formed Department of Computer and Information Science at Seton Hall University in South Orange, N.J., is also president of his own software and consulting firm in Moorestown, N.J. . . . **Jean-Pierre Frankenhuis** has been named M.I.T. educational councilor in Paris. His role: to meet and orient prospective students for the school. — **Gerald L. Katell**, Secretary, 7 Silverbit Ln., Rolling Hills Estates, Calif. 90274

63

I don't know if we have any official statistics available, but it seems that half of the class of '63 has migrated to California. At any rate, half of the people who write notes for publication in this space do indeed come from the Golden State. **Peter Mlynaryk** is practically a neighbor of mine. He is currently a professor and the chairman of the Department of Finance at Cal State University in Fullerton. . . . **Art Connolly**, also in southern California, is still managing the controls engineering department for Datron Systems in Chatsworth. Art reports that he remarried in August of 1977, and his family now includes three children. . . . Working our way north up the San Joaquin Valley, **Tony Geisler** is living in Modesto with his wife Dee and children — Rebecca (7) and Wendy (5). Tony is director of marketing, industrial, for J. Hungerford Smith. The company manufactures and sells fruit and flavors for ice cream and yogurt. Dee is active in the P.T.A. The Geislers enjoy tennis, bridge and traveling around California.

Moving on to the Bay Area, **Steve Zilles** is working for I.B.M. Research in San Jose, in computer software design. Steve's son Craig entered first grade this fall, and Karl, his oldest, is in the third grade. Steve's wife Connie is teaching biology part time at West Valley Community College (assuming Proposition 13, our tax limitation initiative, left enough funds in the budget). . . . **Frank Verlot** is living in Los Altos. He reports that he ran for the city council, losing by a scant 152 votes. Undaunted, he writes that he may run again if the opportunity presents itself. . . . **Stan Stokowski** is in the East Bay working on laser fusion at Lawrence Livermore Labs after five years (1972-1977) at Martin Marietta Labs.

Continuing up the coast, **Bill Baugh** has relocated to Eugene, Ore. He will be an assistant professor of political science at the University of Oregon, teaching international relations and theory and methodology. This past June and July Bill attended a national security education seminar at Colorado College in Colorado Springs.

Although seven correspondents are West Coast residents, there are still a few classmates living in the East. **Steve Bernstein** is the leader of the

Keeping Cool with Nostalgia Instead of Air Conditioning

If the cost of electricity for your air conditioner was a bit much last summer, and your heating bills are too high this winter, go see Ronald W. Cornew, '61, on Long Wharf in Boston. He'll talk you into an old-fashioned ceiling fan, and then he'll sell you one — for $150 and up.

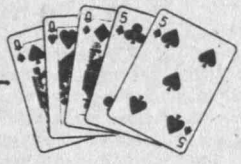
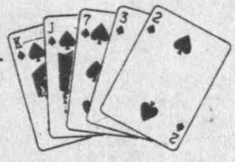
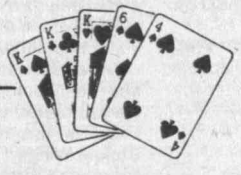
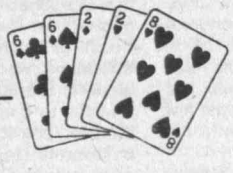
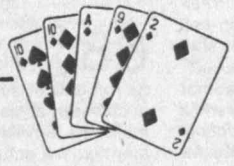
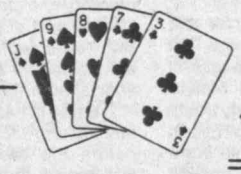
Mr. Cornew admits that his business is riding on the "nostalgia boom," but there's more to it than that. Once they conquer what he calls the "air conditioning mentality," Mr. Cornew says, most customers discover that — at least in Boston — they don't really need air conditioning very often, or very much. And, in winter, ceiling fans can save as much as 30 per cent in heating costs by recirculating the otherwise wasted heat from ceilings.

Ceiling fans come in several sizes — from 36 inches up. If you don't like the basic steel blades (called "paddles" and "wings" in the trade), Mr. Cornew can sell you a fan with oak, walnut, mahogany, or cane inserts as blades — or with brass work on the metal, or even with white enamel paddles. Some old, some new: old fans are "in" now, but most of Mr. Cornew's sales are new ones. For repairs and rebuilding, Mr. Cornew's store — called "Great Things" — has an annex repair shop in South Boston.

How to use a ceiling fan? Think of it as "task-oriented cooling," Mr. Cornew told Peter C. Hotton of the *Boston Globe* during a mid-summer hot-weather interview. "I suggest people look to see where they are most often. Most people spend seven or eight hours a day in one place — in bed, for instance. So put the fan over the bed. I'll guarantee you, you won't need an air conditioner.

"The number-two place is the family room where people spend time conversing, reading, watching you-know-what. There's where your fans should go."

Begun as a hobby to "keep the other side of my mind busy," ceiling fans alternate for Mr. Cornew with Thomte and Co., Inc., an investment counseling business of which he was co-founder (1968) with Ted Thomte, a graduate of the Wharton School. The company was one of the first to offer investors a mutual fund concept based on commodities and foreign exchange (rather than stocks). "I was interested in various kinds of modeling problems as a graduate student and eventually got into modeling capital markets," Mr. Cornew explains. Thomte and Co., Inc., is presently involved in various projects, including management of foreign exchange funds and the development of a program to help large educational institutions protect their endowment funds in the face of domestic inflation and the sliding dollar abroad.

Hand	Example	Number of Hands	Frequency
Straight Flush		40	
Quads (4 of a kind)		624	
Full House		3,744	0.7% for a PAT HAND (Straight or better)
Flush		5,108	
Straight		10,200	
3 of a Kind		54,912	2.1%
Two Pair		123,552	4.7%
One Pair		1,098,240	42.2%
No Pair		1,302,540	50.1%
Total		2,598,560	100%

How Psychology Works With Probability in Poker

"Once upon a time a dog learned to play poker," writes Philip N. Dangel, '64, in the introduction to his new book *Poker: Double Your Skills, Double Your Profits* (Las Vegas: GBC Press, 1977).

"The dog was really deadly because he could smell whether an opponent was paired in five stud or had a good hand in any other game. Yet in spite of this the dog never made any money. Why? Because every time he had a good hand he wagged his tail."

Despite that story, Dr. Dangel (he has three degrees in materials science from M.I.T.) says his book is not at all for "card sharks." He wants to help "the player who plays regularly for modest stakes" understand the game a little better, and the book (according to its author) makes two contributions to poker literature:

—It provides extensive tables of probability and shows their relationship to good, fair, and poor hands.

—To teach "the psychological aspects of betting," Dr. Dangel describes the actual play of more than 100 illustrative poker hands. (Most of the play, he says, occurred at M.I.T., and he recalls of his then-colleagues that "two earned their way through law school playing poker, three were chess masters, two were rated bridge experts, and all were gentlemen.")

Further, on the probablistic aspects of betting, Dr. Dangel writes, "Playing poker is like surfing. The idea of the game is to catch a wave and ride it, the way the surfer does. . . . What kind of waves do poker players ride? Waves of probability are the ones."

Though poker is sometimes described as a game of chance, with odds calculated by relatively straight-forward mathematics, Philip N. Dangel, '64, says it is much more — "the only game of chance except bridge in which the player makes active decisions throughout play . . . allowing a good player to win against players of lesser skill." Both sides — the probabilities, illustrated left, and the psychology — are part of Dr. Dangel's new book, Poker: Double Your Skills, Double Your Profits. *The illustration, from the book, shows the 2,598,960 possible five-card hands (nothing wild) in a 52 card deck.*

Satellite Ground Terminal Group at Lincoln Labs. This June, at about the time of the reunion, Steve was in Munich presenting a paper at a NATO Communications Conference. . . . **James Anderson** lives in the York, Penn., area. His company, J. Hilbert Anderson, Inc., is doing the design and project engineering work for the first hot water geothermal power plant in the country. . . . **Bob Efimba** is in Washington, D.C., where he has just completed a one-year term as secretary and a board member of the National Capital Section of the A.S.C.E. Bob reports that he has now been re-elected to a two-year term as director. . . . **Jim Hadden** is still at Georgia Tech, tooting horns for acoustics in the mechanical engineering department. He reports that being an acoustics booster is ever an uphill struggle, but that he did manage a trip in July, 1977, to the International Congress on Acoustics in Madrid. Jim's other activities center on the home and garden, where the weeds grow like children and the children — Lucy (7) and Jamie (4) — grow liks weeds.

Finally, **Bob Yaes** writes that he is still unemployed. I once asked for letters from those of you living unusual life styles, or whose careers had worked out in unusual ways. I would say that being unemployed is one of the more unusual career results for an M.I.T. alumnus. And, on that note I'll sign off until next month. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92715

64

Greetings '64! Another reasonable month for class notes: one class hero, two alumni envelopes, and an assortment of press releases. I should mention, however, the cupboard is bare. So please write. I'd like to finish out my term with uninterrupted, almost monthly reporting. And remember that 1979 is the year of our 15th. We're in it, let's plan for it, and let's have the best turnout ever.

John Meriwether continues as our premier correspondent. He's also populating my secretarial files (such as they are) with postcards of beautiful vacation spots. The latest one is Trunk Bay, St. John. from Erika and John's first visit to The beach looks magnificent, and early on a Sunday morning they had it all to themselves — "no cans, no footprints, no people."

Michael B. Godfrey is now a Transportation Planning officer for the Missouri Pacific Railroad after being a tenured professor at Ohio State. He and Edith enjoy living in St. Louis with their three sons, the last one born in May. In his spare time, Mike fixes their house and learns bluegrass fiddle tunes. He took the P.E. exam this past April and also learned to drive a train, so Mike says, "I am now a *real* engineer."

Richard McEntire has spent the last six years at the Johns Hopkins University Applied Physics Laboratory doing research in space physics. He is now working on two projects. One is to study the earth's magnetosphere and the other to study the magnetosphere of Jupiter. Robin just completed her Ph.D. in experimental psychology. They have two sons: Paul, 6, and Carl, 1 year.

Press releases tell us that Johnson & Johnson, the health care products manufacturer, has promoted **William A. Nelson, Jr.** to Group Engineering Manager for its midwestern surgical dressing plant and distribution center. Bill has been with the company since 1966. He earned an M.B.A. from Rider College in 1970. Bill and Joyce live in Downers Grove, Ill., with their son, William III.

Kraig W. Kramers has been named Executive Vice President of Nutrition 21, a LaJolla, Calif., food supplement developer. . . . Dr. **Kenneth E. Ekstrand** has been promoted to Associate Professor of Radiology at the Bowman Gray School of Medicine of Wake Forest University. His principal research interest involves the use of computers in planning radiation therapy. . . . **Malcolm C. Easton** has published a paper in the *IBM Journal*, "Model for Database Reference Strings Based on Behavior of Reference Clusters." Mal, a former roommate of mine from undergraduate days, is a member of the storage managemant analysis and algorithms group at the Thomas J. Watson Research Center. He joined IBM in 1973. . . . **Paul R. Ortiz de Montellano**, Assistant Professor of Chemistry and of Pharmaceutical Chemistry, University of California at San Francisco School of Pharmacy, is one of 79 outstanding young scientists in the United States and Canada to be awarded the Sloan Fellowship for Basic Research. His fellowship is for two years to help further his research on the enzyme mechanism of cholesterol biosynthesis and the effects of drugs on metabolism.

Yours truly has some "careerwise" good news to report, too. I have been promoted to the position of Executive Director of the Advanced Support Technology Division of ManTech of New Jersey Corp., the firm I joined in 1975 when we moved to the Washington area. The division currently has about 50 people, supports two major programs and half a dozen smaller ones as technical and management consultants, and develops software, documentation, and standardized procedures related to automatic test equipment. I was also appointed to the newly created corporate position, Director of Planning and Advanced Development.

On the family side, we had a lovely end-of-August two weeks in Ogunquit, with delightfully warm ocean water (58° to 62°F) insofar as Maine goes. Now that we're back, Marlene is having our assortment of in-process home projects completed, and we're both learning a lot about working with and dealing with small building trades contractors. — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md. 20854

65

Peter Sexton has been promoted to Manager of the Industrial Products Division of the metals firm Handy and Harman. The Sextons live in Sandy Hook, Conn.

Ever tried to spin-dry a cat? Pamela, my wife, had left some towels in the drier after the rest of the wash was done. Later in the day she turned it on to finish the towels, only to be greeted by a series of blood-curdling yells. It seems that Harry (alias Hairy Hustler), our elder cat, had decided the drier looked like a nice place for an afternoon nap. It was a short ride, and Harry is none the worse physically, but she certainly gives the drier a wide berth.

How about one about a hamster? No? Well, then, write! — **Edward P. Hoffer**, M.D., 12 Upland Road, Wellesley, Mass. 02181

66

I was in Washington in September and saw **Dave Mundel** who continues at his post at the Congressional Budget Office. Dave and Elizabeth live in D.C. with their two sons, Sam and Nat. While I was with Dave, I spoke with **Al Steinman** who just moved to Washington after spending the last few years hopping around the country with the medical arm of the Coast Guard.

Rich Millman, Associate Professor of Mathematics at Southern Illinois University at Carbondale, has been appointed assistant to S.I.U. President Warren W. Brandt. "I feel Dr. Millman can bring an important faculty viewpoint to our staff discussions and can benefit from the experience," Brandt said of the appointment. Rich is co-author of two mathematics texts, *Elements of Differential Geometry* and *Calculus: A Practical Introduction*, and has written 20 articles. . . . Major **Jim Kester** has assumed command of Detachment Eight of the 31st Weather Squadron at Zweibrucken AB, Germany. . . . **Ralph Davison** writes that he and his wife **Nancy** (**Smith** '66) live in Pittsburgh, but he travels quite a lot in his job as manager of stainless steel development for Climax Molybdenum Co. "I will be operating my company booth at the Solar Energy Industries Assoc. exhibit in October, where we are trying to let people know that an 18 G-2 Mo stainless steel is the optimal material for domestic solar heating systems. Nancy enjoys continued success and growth as an artist, and is in the final stages of her doctoral thesis in American Studies at the University of Michigan. I was elected president of the M.I.T. Club of Western Pennsylvania for this year. We are looking forward to a good year." Some of Nancy's etchings and woodcuts were on exhibit at the M.I.T. Faculty Club in September.

Roland Pittman writes: "After obtaining my physics degree, I attended graduate school at the State University of New York at Stony Brook. I married Sue Story of Levittown, N.Y., in 1968, and received a Ph.D. in physics in 1971. About a year before receiving my doctorate in experimental high energy physics, my interests turned to physiology and I was fortunate enough to obtain a postdoctoral position in the Department of Physiology at the University of Virginia. In 1974 I accepted a faculty position in the Department of Physiology at the Medical College of Virginia in Richmond. I spend most of my time conducting research on oxygen transport in the microcirculation. I was recently promoted to Associate Professor of Physiology. My wife and I have two daughters, Jennifer (6) and Katie (2), who bring us a lot of joy."

As my two year "tenure" as secretary has now ended, I will be passing it on to **Joe Patterson**, 1403 Gerard Street, Rockville, Md. 20850. While at times I did not need the extra work load of pulling together these class notes, overall it's been a lot of fun hearing from you directly and receiving news about you from the Alumni Association. Please try to keep Joe informed as it's a heck of a lot easier writing with lots of news than with an empty file in front of you. See you in Cambridge in 1981 for the 15th. — **Paul Rudovsky**, Former Secretary, 340 East 64 St., New York, N.Y. 10021

67

Paul Tarantino recently visited Subic Bay in the Philippines as an officer on the nuclear-powered aircraft carrier "U.S.S. Enterprise." . . . **Larry Aronberg** has completed his first year at the College of Pediatric Medicine in San Francisco. Ahead lie three more years and residency. . . . **David Kress** is a marketing specialist with Analog Devices Semiconductor in Wilmington, Mass. Prior to joining Analog Devices in 1972, Dave was a staff engineer at Massachusetts General Hospital involved in the design of automated laboratory instrumentation.

Gerald Marandino joined the Foreign Service and has been a vice consul in Nuevo Laredo, Mexico, since July. . . . **Dave Espar** of Veriation Films is the director/editor of "Wild Horses, Broken Wings," an hour-long documentary about a woman, her 15 foster children, and their 150-mile horseback journey into the Gila Wilderness of southern New Mexico. The film had its West Coast premiere in Palo Alto in July. . . . **Joel Strickland**, who has been employed for ten years at Martin Marietta Aerospace in Orlando, Fla., will transfer to company headquarters in Bethesda, Md., for one to two years in an intern program before returning to Orlando. He and his wife have a six-year old son. — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

68

As I write this, we are rapidly approaching the end of summer, at least officially, and I am taking a few moments to reflect on my activities of the last few months. We actually got to Massachusetts twice this summer, once to our dear alma mater for the reunion and once to the islands south of Cape Cod as part of a three-week sail from Annapolis. Both were red-letter events, and both had been anticipated for a long time, so it was really quite a special summer.

I noted as I assembled the meager clippings for this column that some of them date back to before the reunion, demonstrating once again that system turnaround is rather slow. So some of the "news" may be old hat to those who attended the reunion, but for the benefit of those who haven't heard, I'll report the older items briefly:

Steve L. Lerner, M. Arch. '71, was presented the First Award for Excellence in Architecture for his design of the Ellen Sharpe Dormitory (left) at Brown University by the Rhode Island Chapter of the American Institute of Architects. The jury commended the design for its very sensitive, intelligent use of a difficult site. The building was needle-threaded to accomodate the existing buildings and garden and shows innovative compatibility of materials, scale, shape and form.

Sue and **Tom Terwilliger** sent us a letter summarizing what they'd been up to since graduation. After receiving a Ph.D in chemistry from Yale in 1973, Tom went to Purdue for a postdoc. He then moved to Dayton, working first at Wright-Patterson Air Force Base and then at Wright State University. This past January he came to Philadelphia to be Director of the Mass Spectrometry Center at the University of Pennsylvania. Tom describes the job as quite a challenge and says that he and Sue experienced somewhat of a shock returning to the high cost of living in the northeast after five years in the midwest. Tom and Sue have a daughter, Emily, age 3, who seems to be learning her alphabet faster than the numbers — "she must get that from her mother."

Mike Yokell reports that he recently left the University of California, Berkeley, where he had held a position as Visiting Professor in the Energy and Resources Program and Economics Department to accept a position as Senior Economist at the new Solar Energy Research Institute in Golden, Colo. . . . **Dennis Sager** recently graduated from Eastern Virginia Medical School. However, he says, he is still interested in the aerospace engineering world, and he tries to keep up with it. Dennis and Jeanni had a second daughter, Deborah, on May 16, 1977.

In other news, **Stephen Bowers** has been named Executive Vice President — Administration by Wright, Pierce, Barnes and Wyman, Topsham engineering and planning firm. He had been Vice President — Marketing for the firm and will now add financial, data processing, and personnel functions. . . . Finally, **Harry Goldmark** has been appointed to the active staff of the Leominster Hospital as an orthopedic surgeon.

No we have depleted our cache of news items, so please drop us a note to replenish our stockpiles. — **Gail** and **Mike Marcus**, Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

70

William Michels, an associate with Booze, Allen and Hamilton, Inc., in New York city, has been elected to the Institute of Management Consultants. . . . **Wesley F. Moore** took a trip back East in the summer and saw Nancy and **David Hall**'s new house in New Jersey. David is a postdoctoral student at Albert Einstein. . . . **Dick Voss** had dinner with them and explained his "noise studies" as an I.B.M. employee. . . . **Marc Weinberg** was the next visit on his trip. Marc is working on missile guidance systems. The Vegelers are putting most of their efforts into building a new house which takes all of our time except for a few weekend football trips. — **Robert Vegeler**, Secretary, Kennerk, Dumas, Burke and Backs, 2120 Ft. Wayne National Bank Bldg., Ft. Wayne, Ind. 46802

71

I have learned that many members of our class are listed as members of another class. If you graduated in another year, but you feel you belong to the class of '71, let me know when you write in or you will automatically be transferred to the other year. Witness the plight of poor **Richard Hill** who writes, "I wrote to you some months ago and saw my letter published in the class of '73 notes. While I did graduate in '73, I really belong to the class of '71 since I dropped out of M.I.T. for a year and then went back part time. All my friends were in '71 or earlier classes and I don't know anybody at all in the classes of '72 or '73, nor would I ever attend a '73 reunion. Can't I please be included in the class of 1971? As you see from my address (Habsburgerstr. 46, Luzern Switzerland), I now live and work in Switzerland. Lucerne is a very pleasant little town and both of us are enjoying life here. I am a research statistician in the European headquarters staff of A. C. Nielson Co., which is well known for its T.V. ratings but derives most of its income from the audits of retail sales (e.g. sales of Ivory soap). It is the world's largest marketing research company, operating in 23 countries. My wife, Karen Larsen, will continue to study viola de gamba at the music academy in Basel."

Famous Fiji, **Fred Horr**, and Delt house tutor **Stu Johnson**, sent me a postcard that was written between sips of wine on the Champs Elysee in Paris. They left no return address nor did they say why they were in Paris. They merely indicated they were enjoying themselves, something they both do quite well.

Please write, your classmates want to know what you are doing. — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, Tex. 77833

72

If no news is good news, this is a banner month for '72. I received no news from anyone, however by diligent inquiry I have the following for you: **Chip Kimball** was married over the summer to Susan Bryant, whose parents were faculty residents in McCormick a few years back. . . . **Paul Levy** has been named Commissioner of the Massachusetts Department of Public Utilities. . . . **Warren Lippitt** has moved to Chicago where his wife is a resident at Michael Reese Hospital. . . . **Bonny Kellermann** spent part of the summer in Europe and is now back, hard at work in the Dean for Student Affairs Office. . . . **Cheryl Davidson Martin**, her husband Jow, '71 and their new daughter have moved to Cincinnati. — **Dick Fletcher**, Secretary, 135 West St., Braintree, Mass. 02184

73

Hello again from the Athens of . . . oh, not that again! The veritable plethora of epistles that wellnigh drowned me these many months has dwindled into a non-trickling crick. I did, however, receive a personal letter from **Mike Moritz**, who writes, "I'm currently living in Tokyo, working in the capacity of Manager of Far East Operations for Codex Corp., trying to reverse the balance of payments by selling to the Japanese Codex' nifty line of products. I've been living here since January, and expect to be here through 1980. Any M.I.T. folk here are invited to visit me (1-2-8 Yotsuya, Shinjuku-ku, Tokyo 160).

And that, pals, is it. I saw **Jean Ward** recently, who regaled me with tales of the reunion and such. Forgot to ask him what he's doing. Sorry about that. Yours truly has left Burroughs for Electronics for Medicine in Sudbury, from whence I leave for Chicago in April. Between jobs I stopped off at Rush Week to watch the good ol' Phi Delts beat the pants off them other houses (Fiji, Fiji, are you still there?) Ah, class will out, n'est-ce pas, Tony Scandora, whenever you are? Write! — **Robert M. O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

75

As always, many thanks to those of you who have written. . . . **Seth Stein** finished his Ph.D. in geophysics at Caltech and immediately departed for a summer's backpacking in the Canadian Rockies. After a "spectacular" summer, he is now settling down for a postdoc at the beautiful Leyland Stanford farm. . . . **Mitchell Lewis Green** and his wife Susan moved to Chicago in October. He joined Skidmore, Owings and Merrill as an architect. Susan has joined the adjunctive therapy staff of Pritzker Children's Psychiatric Unit, a part of the Michael Reese Medical Center. . . . Congratulations to **John Hoffman** who tied for top in his class for his first two years of medical school at the University of Wisconsin. . . . Fron the *Wayland Town Crier* (Sudbury, Mass.) I learned that **Bill Sneider** was awarded the doctor of medicine degree from Baylor College of Medicine. He is the recipient of Bastz Science Honors and will be doing a surgical residency at Boston University Affiliated Hospitals.

I received two very nice and informative letters bringing me up to date on the lives of a couple of classmates. **Stephen P. Ralston**, after graduating from Department XV, took a job as assistant trainer at Laurel Race Track (1975-1976). He then went on to bigger and better things by becoming a professional gambler on the ponies (1976-1977) and then a graduate student in history at the University of Maryland (1977-1978). This past June he was offered a job he couldn't refuse and is presently the assistant director of advertising for Gardisette, Inc., the number one drapery company in Europe, with international headquarters in Switzerland and U.S. headquarters in Anderson, S.C. . . . **Chuck Digate** of Sigma Chi fame worked as a research organic chemist for Uniroyal Chemicals in Naugatuck Conn. immediately after graduating. He then attended the University of Michigan Business School and received the M.B.A. in finance and business policy, completing his "transition from a Bostonian liberal to a conservative businessman." He then took a position with Texas Instruments in Dallas and spent his first ten months in T.I.'s control management program. He's recently had a two-step promotion to control manager of the professional calculator division in Lubbock, Tex. He says, "Lubbock is not heaven but it suffices as an excellent place to invest in a house and a good place to reflect on the wanderings of the human consciousness." (I take it this means there's not much nightlife.) Chuck, thank you for the letter — it was well worty deciphering your handwriting.

Special thanks to **James Leung** who helped me plug in the I.B.M. Selectric which I used to type this column.

That's it for now. I'm always glad to hear from you. — **Jennifer Gordon**, 22 Centre St. No. 9, Cambridge, Mass. 02139

76

I hope you have all been enjoying these notes. If more of you wrote, there would be more to enjoy.

I bumped into **Gail Rubin** just prior to the deadline for this issue. She tells me that in addition to her and **Jim Miller** working at Bolt, Beranek and Newman, there are two other classmates to be found there: **Arthur Gottlieb** and **Tony Lake**. . . . One of my "sources" informed me that **Hillary Morgenstern** is now attending optometry school.

From the mails: **Howie Tanzman** writes: "went to Carnegie-Mellon to get a master's degree in Industrial Administration (M.U.'s equivalent to an M.B.A.) I did receive the degree with distinction. I now work for Ford Motor Co. as a financial analyst in their world headquarters in Dearborn, Mich. However, I still drive a V.W. My chauvinistic Boston friends who were unimpressed when I moved to Pittsburgh, laughed even harder when I told them I was moving to Detroit (until I told them my salary, that is). One thing I miss is good ice cream — people wonder why I look disappointed when told that Baskin-Robbins is the best ice cream place." He also writes that **Sue Litvin** is working just down the hall as a financial analyst, too. . . . **David Stork** sent a brief note, "Just after my 'home' sickness for the Boston area, I was ecstatic when I received an invitation to teach an elementary physics course at Wellesley this fall. With only two and one half weeks notice, however, I'm frantically checking references, choosing texts, planning lectures and labs, on top of the more banal chores associated with moving selected possessions to Wellesley and finding a place to stay. Next spring, I'll be back at the University of Maryland Physics Department working on my dissertation."

From **Gregory De Witt**, we have a postcard indicating he spent the summer working at Bell Telephone Labs in Chicago. . . . **Jerry Dausman** has finally written, "Since I graduated in '76, I have submitted myself to two more years of rigorous study at the Sloan School for an S.M. These last two years I had also been asked, by the rifle coach, to stay on as an assistant coach. That I gladly did and learned a lot. The combination of coaching rifle and studying management paid off. I am now working in the Education and Training Division of the National Rifle Assiciation — helping them develop projects. I really enjoy my job." For those wishing to write or visit Jerry, his new address is: 5209 16th St. North, Arlington, Va. 22205. Jerry sent an amusing postscript. "I'm thinking of starting a business — shipping all the Capitol Hill hot air up to New England to heat homes in the winter."

Jeff Baerman writes that he has "finished my junior year internal medicine rotation. It's hard to believe that the time has gone by this quickly. The hours were incredibly difficult — a truly backbreaking schedule. However, despite the fact I was working my fanny off, I did really enjoy it. I am pretty happy about what I am doing. Only one and one half years to graduation. I've got three weeks of vacation. Right now, I've got no big plans aside from relaxing and catching up on sleep, but I am leaving for a two-day stay in Ames, Iowa, upon old running buddy Frank Richardson's ('77) invitation. He is in vet school at Iowa State. Other than that, I'm trying to do some reading and viewing at the Chicago Art Institute."

I ran into **John Hanzel** while he was passing through Boston. John *promised* me a letter after he went to the alumni reunion at his frat. John, I'm still waiting for you to live up to your promise. (John is still working at his family's art gallery/auction house in Chicago and loves it.)

As for your secretary, he has opened up an office in the heart of Boston's financial district and has four employees. If business continues to grow as projected, it will be doubling in size and employees shortly. — **Arthur J. Carp**, Secretary, Endymion Commodities, Inc., 131 State St., Suite 616, Boston, Mass. 02109; 617-367-9690.

77

A great deal of information has wafted my way in recent months so strap yourself in and off we'll go. Robert Wolff, '78, is currently a Senior Scientist in the Earth and Space Sciences Division, Planetary Atmospheres Section, at the Jet Propulsion Laboratory in Pasadena, Calif. He is working on GALILEO (a Jupiter orbiter with probe) Comet-Ion Drive mission to Haley's Comet, and the Venus Orbiting Radar Mission. . . . **Kathy Dawson** is in the scenic Pacific Northwest employed as a test engineer for Boeing Aerospace doing work with vacuums and cryogenics for their Space Environmental Lab. She still has her folkdancing shoes on and occasionally encounters **Alex Orlovsky** who works in the Commercial Aircraft Division at Boeing.

Richard Steinberg survived his first year at the University of Pennsylvania in their economics Ph.D. program, adding that it is emphatically not Wharton. He probably doesn't want to be confused with us Business School types. Speaking of which, Steve Kaplan, '76, just transferred to Sloan School from Yale Business School where he spent the past year. Out at the University of Chicago, **Julia Malakie** finished up the first year of their M.B.A. program and spent the summer in the St. Louis area working at Monsanto's corporate headquarters.

Sarkis Koltookian is a development engineer for John Deere Industrial Transmissions. "I've restored the bodies of a '57 and a '58 Corvette in the time I've been out here. I crashed my Corvette, but it'll soon be mint again." Sounds like life can be exciting in the Midwest afterall. . . . **Stephen Obiath** is with the University of California's (Berkeley) chemistry department in their Ph.D. program. . . . **Steve Brown** received his master's last June and is currently in flight school at Reese A.F.B., Texas. "If any friends are passing through, be sure to look me up."

Willie Johnson is in P&G's employ as a shortening and oils process technical engineer in the soap, food, and general engineering division, and is pursuing a master's in chemical engineering at the University of Cincinnati on a part-time basis.

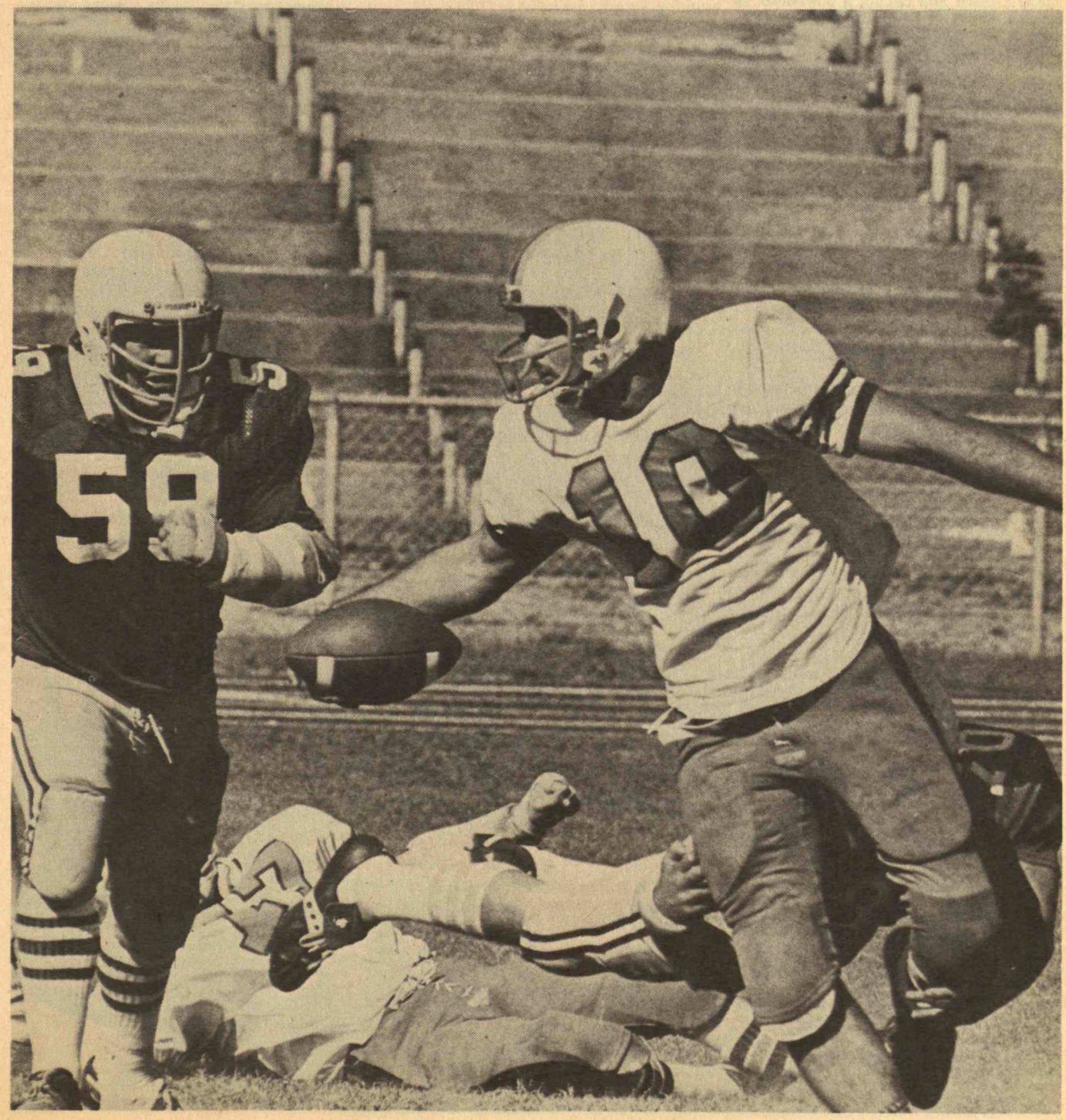
Our espoused classmates **Jeff Weiss** and **Nancy Freeman** sound as though they are keeping their time well occupied, Nancy is at New York Medical College and Jeff is with IBM at the T. J. Watson Research Laboratory. . . . **Dan Fairweather** enjoys playing hockey in a Flint, Mich. men's league when he isn't busy at A. C. Sparkplugs. He's in the ceramic division developing catalysts for exhaust emission control. . . . **David Doo** is in Fullerton, Calif., working for Hughes Aircraft in air defense programs. . . . **Rick Ulene** is in his second year at U.S.C. Medical School and spent the past summer as a psychiatric fellow. He is also doing TV consulting work.

Joan Lund is working with juveniles as part of a legal services program while in her second year of law school. She spent the summer doing research in criminal law. . . . Digital Equipment Corp. has yet another M.I.T. engineer, **Arthur Wilding-White**, who is working at the Maynard facility as a software engineer. . . . **Dan Rice** has joined the ranks of high finance as a stockbroker at Merrill, Lynch, Fenner, etc. in their office in the Pan Am building in Manhattan. "I am a dedicated New Yorker and believe it's the best place to live." Well, there's no accounting for the poor misguided fellow's taste.

Finally, a note on the back of a recent Alumni Fund contribution envelope, **Geoff Young** is pleased to announce that he's become a practicing anarchist, dedicated to the speedy replacement of our violent, oppressive and corrupt society. To this end, he's exploring alternative energy paths, organic homesteading and mind-altering drugs.

Well, what can I say except keep those cards and letters coming in. Until next time, Ta-Ta. — **Doug McLeod**, Secretary, 11 Silvey Pl. No. 1, Somerville, Mass. 02143

Shades of the Big Ten. That's quarterback Bruce J. Wrobel, '79, carrying the ball for M.I.T. against Fitchburg State College in an historic game on September 23 — the first appearance of cardinal and grey football uniforms from Cambridge since 1941. Though the score was 27-12, football's advocates were undaunted. The "club" was scheduled for two more games, and The Tech *was lamenting the "high-handed" manner in which President Henry S. Pritchett "eliminated" football from M.I.T. back in 1900. (Photo: Gordon R. Haff, '79, from* The Tech)



M.I.T. Student Becomes World Champion Rocketeer

In Jambol, Bulgaria, Harold "Guppy" Youngern, '76, and 12 other American model rocket enthusiasts entered into tough international competition last fall. The world champion rocketeer title was won by Mr. Youngern — the first time the championship was won by an American. "We're riding right on the hairy edge of technology," he exulted.

His rocket-powered, radio-controlled glider was tied with a Bulgarian plane at the end of three rounds. Then "we had a very exciting fly-off" for the championship, he explains. Final flights were in an open field; the Bulgarian launch was made in a poorly chosen place and caught a downdraft, resulting in a short flight. So Mr. Youngern tried not a make the same mistake. But his craft hit a downdraft as well — yet the flight lasted slightly longer than his rival's, and the prize was his.

"Traditionally, the Czechs have been the winners," said another member of the team, Bernard A. Biales, '66. But this time, the United States team took first, fourth and sixth place, while the Bulgarians took second, third, and fifth.

The M.I.T. team is committed to perfection. Some of their rockets and planes were almost exact scale models of the famous X-2 rocket plane built in the mid-1950s for experiments in high-speed flight. One was a replica of an American sounding rocket that even duplicated tiny rivets.

Robert W. Parks, '73, made and flew the X-2 model; John S. Langford, '79, built the near-perfect sounding rocket model. Geoffrey A. Landis, '77, was the other M.I.T. member of the United States team.

The Bulgarians rolled out the red carpet for their M.I.T. visitors (who paid most of their own expenses); ceremonies, a parade, a concert and folk dancers welcomed them.

And four Bulgarian medals from the competition and a tall crystal vase signifying the world championship accompanied the triumphant team home.

A Comparison: Harvard Versus M.I.T.

By William Lasser, '78

Harvard University — At the risk of making too hasty a judgment of this august institution, I have endeavored to set out in the following paragraphs a few impressionistic comparisons between Harvard and M.I.T. While my goal has been one of unshakeable objectivity, my reportage has no doubt been affected by the vast difference in the amount of time I have spent at the two universities: four years at M.I.T. and two weeks at Harvard. Nevertheless, with that caveat explicitly understood from the outset, it is my view that, compared to M.I.T.:

☐ *Harvard is older, more imposing, and far more traditional.* One very quickly realizes here that he is, well, *at Harvard*. The campus, especially Harvard Yard, oozes with history; architecturally, for certain, and perhaps intellectually, the institution is less future-oriented than M.I.T. and seems instead to be searching the past for guidance. Students, too, are concerned with tradition; it does not take long for a new student to be told, for example, that Widener Library stands as a memorial to Harry Elkins Widener, who perished at sea along with the *Titanic*. Think about it: does anybody at M.I.T. know for whom Kresge Auditorium is named? Or care?

☐ *Harvard is more pervadingly intellectual.* Intellectual, that is, in the sense of politics, literature, the arts, and philosophy. It is quite natural for the *Crimson* football reporter to compare Harvard Coach Joe Restic to Shakespeare's *Richard III* one week and Machiavelli's *Prince* the next; both he and his readers are accustomed to thinking about everything — even football — in such terms. Indeed, this would-be Heywood Hale Broun hit upon the most appropriate metaphors in his gridiron coverage and was able to convey his exact meaning to an audience consisting largely of government, English, and economics majors. When Harvard people make literary or historical references or use ten-dollar words, they are acting naturally and not putting on airs; just as when M.I.T. people toss about mathematical concepts, they are only doing what comes naturally. This does not mean that, in other ways, Harvard people do not put on airs: see below.

☐ *Harvard is more pretentious.* Certainly, Harvard men and women are erudite, but they often go far beyond the bounds of reasonableness and become haughty. For example, it is perfectly acceptable for the *Harvard Crimson* to refer to alumni and students of Harvard College by citing the person's class year, as in "John Smith, '62." *The Tech* does it, and so do many other college papers. Still, I think it goes too far when they refer to our thirty-second president as "Franklin Delano Roosevelt, '04." That's uncalled for. (It made me wonder if they abbreviate his name "FDR04.") That kind of thing gives Harvard a bad name. It's a symptom, I think, of a larger problem — what was described to me as "Harvard Centricity," which leads Harvard types to believe that their university is the hub of the intellectual universe. The best example of that disease I've encountered was the reaction of a woman in the Harvard Parking Office to my question as to whether Harvard had a street address. "Just put down Cambridge," she sniffed, obviously firm in her conviction that Harvard doesn't *need* a street address. "If they can't figure *that* out, they're in trouble."

☐ *Harvard has more preppies and would-be preppies.* Of course, it doesn't help Harvard's image for there to be so many Oliver Barrett III's running around in chinos and V-neck sweaters, even on days when the temperature is seventy-five degrees. It's probably just my imagination, but a lot of students seem to resemble Ryan O'Neal. Still in all fairness, most of the undergraduates go to classes dressed like normal college students; they're just overshadowed by their Eton-esque classmates.

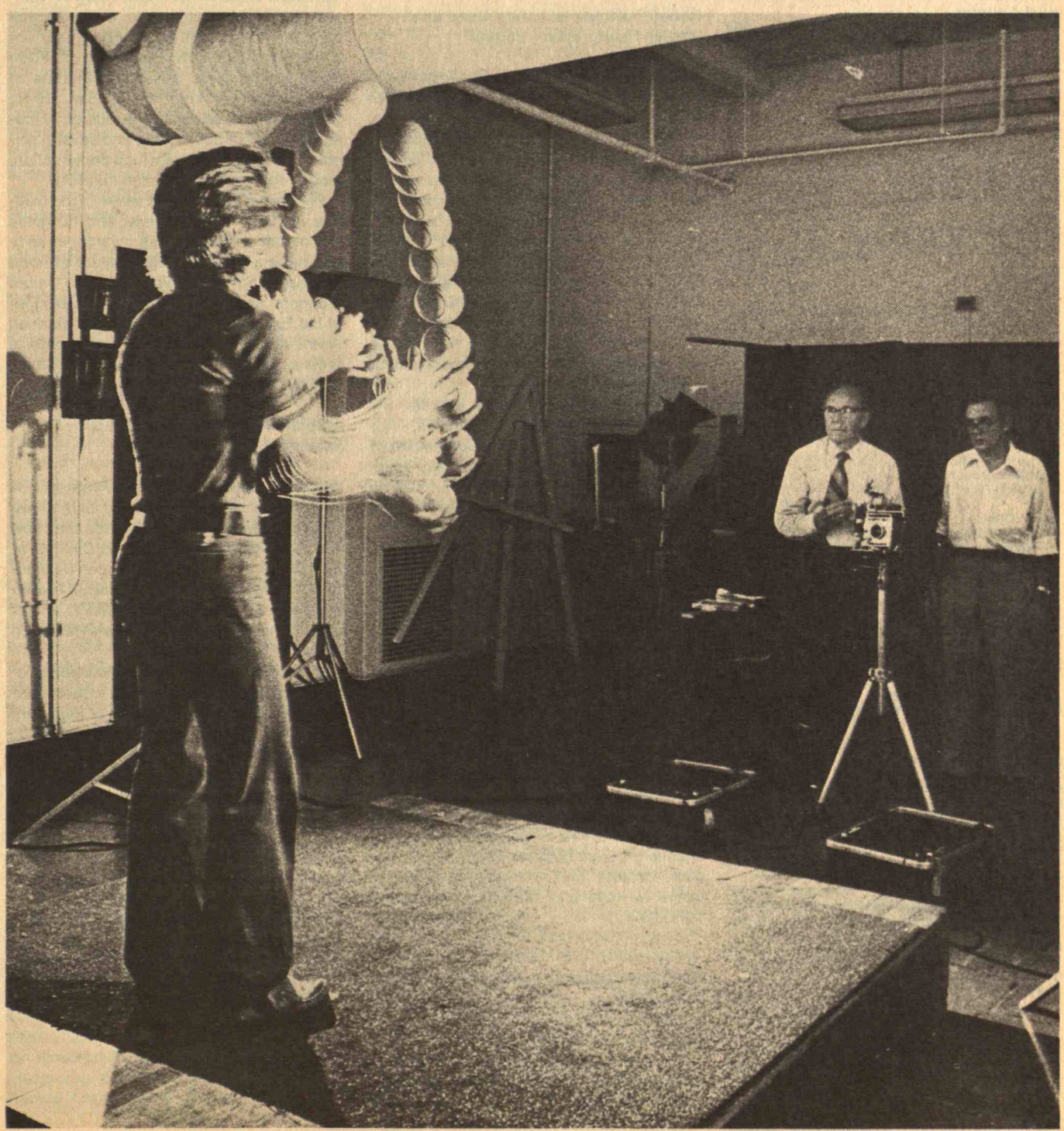
☐ *Harvard people are less friendly.* This applies especially to staff people, such as librarians and secretaries. M.I.T. has a great many people who are ready to help others, who will even help totally lost new students. Their Harvard equivalents make you feel that you are wasting their time. These people are representative of the institution and can make you feel either welcome or unwanted. M.I.T. extends a warmer welcome.

☐ *Harvard couldn't care less about a "Harvard-M.I.T. rivalry."* While M.I.T. students view "that liberal arts school up the creek" with contempt, Harvard students rarely discuss or think about the Institute. Harvard's rival is Yale, plain and simple. Coming from M.I.T., I expected a certain amount of friendly jokes about my undergraduate origins. I have received none.

I will attempt to alienate neither my alma mater nor my present university by venturing an overall comparison between the two institutions. Each has its faults, but each offers a uniquely enriching experience.

William Lasser, '78, is studying American politics and political theory at Harvard.

Preparing for its fall TV special on "The Invisible World," the National Geographic Society sent its cameras (of course) to Professor Harold E. Edgerton's Strobe Lab. With them came Skip King, a professional juggler, who's shown here in front of a camera operated by Professor Edgerton (left) and his long-time associate, Charles E. Miller, S.M. '66, Lecturer in the Department of Electrical Engineering and Computer Science. (Photo: Calvin Campbell)



Robert L. Halfman

Robert Halfman Is Acting Dean as a "Major Reappraisal" Begins

"Most of my best friends are students," says Robert L. Halfman, '44, Professor of Aeronautics and Astronautics who is now Acting Dean for Student Affairs, following the resignation on September 1 of Dr. Carola Eisenberg. (She is now Dean of Student Affairs at Harvard Medical School.)

Professor Halfman has worked part-time in the Dean's Office since 1972 as Associate Dean for Student Affairs, serving as senior member of the counselling section. He'll continue in that role, and he'll also continue as Chairman of the Experimental Study Group, an alternative program to provide a unified educational experience for freshmen and sophomores.

As Acting Dean, Professor Halfman will report to Constantine B. Simonides, Vice President of the Institute, who for the rest of this year will be conducting a "major reappraisal" of the functions of the Dean's Office and of the "future organization and structure of student support responsibilities." The quoted words are those of Paul E. Gray, '54, Cahncellor, for whom the reappraisal will be made. As he announced the reappraisal, Dr. Gray made his own personal tribute to Dean Eisenberg — "at once a valued colleague and an effective performer in a role which is among the most demanding, difficult, and conflict-ridden in the university," he said.

Professor Halfman joined the faculty in aeronautics and astronautics in 1948, after receiving his master's degree in that field at M.I.T. in 1947. He was Executive Office of the Department from 1957 to 1961 and later served briefly as its Deputy Head. During most of the 1960s he was active in the exchange program between M.I.T. and the Indian Institute of Technology at Kanpur, where he taught in 1962-63 and again in 1966-68.

Goldblith Succeeds Lampert in Resource Development.

Samuel A. Goldblith, '40, whose M.I.T. career began with research on food preservation through freeze drying and high-voltage radiation, has been named Vice President of the Institute for Resource Development. He succeeds the late Lt. General James B. Lampert, S.M. '39, who died during the summer; and in his new role Professor Goldblith will be the principal administrative officer for M.I.T.'s current $225 million Leadership Campaign.

Dr. Goldblith has been a member of the Institute's Resource Development staff since 1974, when he became Director of the Industrial Liaison Program. In the four years since then that Program has attracted a substantial number of new corporate members, and the Industrial Liaison Office now provides ever-growing services to more than 170 companies who are associated through it with the Institute.

Before joining I.L.O., Dr. Goldblith was Associate Head of the Department of Nutrition and Food Science, in which he still holds the distinguished chair of Underwood-Prescott Professor of Food Science. He holds advanced degrees in food technology from M.I.T. (S.M. 1947, Ph.D. 1949), and he is the author or co-author of some 300 articles and several scientific books dealing with food preservation, food processing, and human nutrition.

Professor Goldblith is a fellow of the Institute of Food Technologists, and he holds five of that society's major awards; in addition he is a Fellow of the Institute of Food Science and Technology of the United Kingdom, and he is a Trustee and member of the Executive Committee of the Nutrition Foundation. He's also a Director of several firms in the food industry, throughout which he is widely known.

A Solar Wind Expert Heads Space Research

Herbert S. Bridge, Ph.D. '50, Professor of Physics who is widely known for his key work in mapping the solar winds that flow through interplanetary space, is Director of the Center for Space Research; he succeeds Professor John F. McCarthy, '46 who is on leave of absence from M.I.T. to become Director of N.A.S.A.'s Lewis Research Center in Cleveland, Ohio.

Dr. Bridge has been Associate Director of the Center since 1964, and he's been principal investigator for a number of important solar wind experiments centered at M.I.T. He was awarded N.A.S.A.'s Exceptional Scientific Achievement Award in 1974 for contributions to the 1973 Mariner Venus/Mercury Project.

Thomas F. Jones, Jr., Sc.D. '52, cited Dr. Bridge's "excellent relationships" with space scientists at M.I.T. and elsewhere, his "long-time association" with the Center, and the "great variety of projects" for which he's been responsible in enumerating his qualifications for the new job. Dr. Bridge has been at the Institute since 1946, and he joined the faculty in 1966.

Davidson Named for Fusion

Ronald C. Davison, formerly Assistant Director for Applied Plasma Physics in the Department of Energy, has joined M.I.T. as Professor of Physics and Director of the Plasma Fusion Center; in the latter post he succeeds Professor Albert G. Hill, former M.I.T. Vice President for Research, and Professor Lawrence M. Lidsky, '62, both of whom served as Acting Directors while the search for a permanent Director continued.

While at D.O.E., Professor Davidson was on leave as Professor of Physics and co-Director of the Maryland Fusion Research Program at the University of Maryland.

Dr. Davidson came to the University of Maryland in 1968, having completed academic work at McMaster University, Canada (B.W. 1963), and Princeton (Ph.D. 1966); he was for two years research physicist at the University of California, Berkeley, and since 1968 he's held a number of fellowships and served as a Guest Lecturer at the Center for Theoretical Physics, Trieste, Italy. He is a member of D.O.E.'s Fusion Power Coordinating Committee and of the Executive Committee of the American Physical Society's Division of Plasma Physics.

Individuals Noteworthy

New Appointments at M.I.T.

Karen C. Cohen, Director of Educational Research and Development in the Center for Advanced Engineering Study, is now a Principal Research Associate at M.I.T.; she's a consultant in science and engineering education, and she's in charge of a C.A.E.S. project for a new system of continuing education for scientists and engineers in industry. . . . **Stanley G. Hudson,** Associate Director of the Undergraduate Research Opportunities Program since 1974, is now Associate Director of the Student Financial Aid Office. . . . **Richard W. Keefe,** Assistant Director of the Development Office, to Associate Director. . . . **Lawrence E. Milan,** who has been in student affairs and personnel management at the State University of New York at Oswego, to Personnel Officer in the Office of Personnel Services.

Arthur R. Kantrowitz, Visiting Institute Professor at M.I.T., has retired as Director of the Avco Everett Research Laboratory, Inc., a subsidiary of Avco Corp. which he founded to exploit high-power lasers, magnetohydrodynamics, and other high-technology systems.

Appointments in the Administration

Allan S. Bufferd, '59, Assistant Treasurer, now has the additional title of Recording Secretary — an assignment in which he succeeds Frederic W. Watriss, '41, who retired on June 30. Mr. Bufferd will be assisted by **Winifred T. McDonough** as Associate Recording Secretary; he has also been named Clerk of the Trustees of M.I.T.'s pension and retirement plans.

Lawrence M. Lidsky, '62, Professor of Nuclear Engineering, is Acting Director of the Plasma Fusion Center, succeeding Professor Albert G. Hill, former Vice President for Research.

Robert A. Sherwood, formerly Director of Housing and Associate Dean of Student Affairs at Salem State College, is Associate Dean for Student Affairs with major responsibility for the housing system. He told *The Tech* he looks forward especially to working with "the Institute's rather atypical system of student-governed housing and judicial boards."

Two new appointments in the Council for the Arts: **Elsa G. Sonnabend** is Associate Director and **Deborah A. Hoover** is Assistant Director. Ms. Sonnabend comes from a varied background in fund raising and management, describing herself as a "professional consumer of the arts"; Ms. Hoover was formerly associated with the National Endowment for the Arts, Washington, D.C.

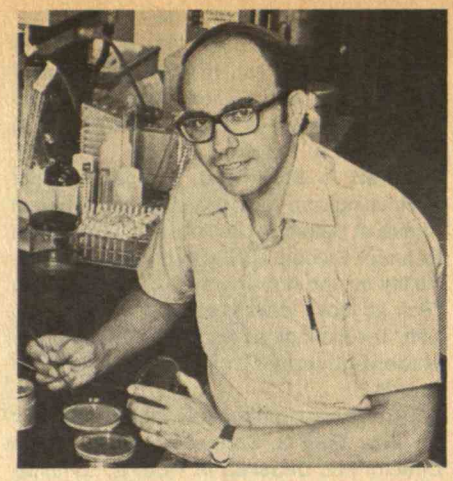
Rising and Changing in the World of Business

Francis D. Russo, Jr., '61, appointed senior methods engineer in the corporate management services group of the Stanley Works. He joined Stanley in 1963 . . . **Stanley N. Golembe,** '42, named a vice president and general manager of Itek's measurement systems division. He joined the division in 1969 as director of operations . . . **Stanley B. Zdonik;** '41, manager of the process engineering department of Stone and Webster Engineering Corp., elected a vice president . . . **Kraig W. Kramers,** '64, formerly director of corporate planning for Fibreboard Corp., named executive vice president of Nutrition 21, a La Jolla based food supplement developer.

Peter Sexton, '65, promoted to manager of the industrial products division of Handy and Harman. He has been with the company since May, 1977. . . . **H. Joel Strickland,** '67, an employee of Martin Marietta's Orlando division for ten years, has been selected as the first person to enter the company's newly created technical operations intern program. . . . **Herbert M. Priluck,** '59, has joined Steffian-Bradley Associates, Inc., a Boston architectural and planning firm. . . . **Peter Alexander,** Ph.D. '71, appointed manager of applications at C.S.P., Inc.

John A. Gautraud, '46, promoted to vice president of engineering for the precision products division of Northrop Corp . . . **Horace H. Homer,** '38, appointed a senior scientist of G.T.E. Lighting Group . . . **Ormand J. Wade,** S.M. '73, former executive assistant for federal regulatory matters in A.T. and T.'s General Departments, elected vice president — staff for the company's Long Lines Department . . . **Hans R. Scharer,** '58, promoted to product manager, extruder division of the polymer processing machinery group at Farrel Co.

Jack Levy, '73, promoted to director of financial planning for The Beacon Com-



P. R. Schimmel

panies . . . **L. Stephen Bowers,** '68, vice president of marketing for Wright, Pierce, Barnes and Wyman, named executive vice president of administration . . . **Harry J. Fitzpatrick,** '49, former marketing vice president of the energy products division of Lear Siegler, Inc., promoted to president of that division . . . **Philip C. Lutzi,** N.E. '57, appointed East Lyme town water engineer.

Robert Spinrad, Ph.D. '63, most recently vice president, systems development division of Xerox Corp., named vice president, research and manager of the Xerox Palo Alto Research Center . . . **Richard W. Ahrons,** '53, appointed to the new position of manager, microprocessor and memory product marketing and support engineering at the R.C.A. Solid State Division . . . **Arthur A. Blanchard,** '65, has joined the Midrex Corp. as manager of project development.

Honors and Awards to the M.I.T. Family

To **Martin A. Abkowitz,** '40, Professor of Ocean Engineering, a Fulbright-Hayes Award to lecture at Technion — Israel Institute of Technology . . . to **Morton Berlan,** Superintendent of Telecommunications, a commendation from the Governor of Massachusetts for his work on the State's Telecommunications Advisory Committee . . . to **Harriet Casdin-Silver,** one of the nation's leading holographers, a Rockefeller Foundation grant to continue work as a Fellow of the Center for Advanced Visual studies . . . to **Jacqueline S. Casey** and **Ralph M. Coburn,** '47, of M.I.T. Design Services, inclusion in the 1978 edition of *Who's Who in American Art* . . . to **Charles E. Holt III,** Ph.D. '62, Associate Professor of Biology, a Fulbright-Hayes Award for research at the University of Gottingen, Germany . . . to **Daniel G. Quillen,** Professor of Mathematics, the prestigious Fields Medal of the International Congress of Mathematicians for outstanding accomplishments by a young mathematician . . . to **Paul R. Schimmel,** Ph.D. '66, Professor of Biochemistry and Biophysics, the Pfizer Award in Enzyme Chemistry of the American Chemical Society for his "extensive contributions" to the understanding of protein synthesis . . . to **Giuliana C. Tesoro,** Adjunct Professor of Mechanical Engineering, the Achievement Award of the Society of Women Engineers.

Nicholas Catsimpoolas, Associate Professor of Food Biochemistry, is Editor of *Cell Biophysics,* a quarterly journal on the separation, identification, and properties of cells. . . . **Jay W. Forrester,** S.M. '45, Germeshausen Professor of Management, to the Advisory Council of the Institute of Administration and Management at Union College, Schenectady, N.Y. . . . **Jay W. Lucker,** Director of Libraries, to the Council of the American Library Association.

Two members of the M.I.T. community were in international sports competition last summer: **Harold (Hatch) Brown,** Varsity Sailing Coach, was named by the U.S. Yacht Racing Union to coach the U.S. team in the second annual World Women's Sailing Championships in Monnikadam, Holland; and **Diane Medved,** '80, traveled throughout Europe as a member of the U.S. National Women's Rowing Team.

Counselors: Officers, Directors, Advisors

Richard C. Bradt, '60, professor of ceramic science and engineering, named head of the Department of Materials Science and Engineering at the Pennsylvania State University . . . **Edmund H. Shead, Jr.,** '52, executive vice president and a director of the J. F. Shea Co., named to Loyola Marymount University's board of trustees . . . **Harry Goldmark,** '68, appointed to the active staff of Leominster Hospital. Dr. Goldmark is an orthopedic surgeon.

Neil D. Morrison, '49, vice president and general manager of Farrel Co., named a director of the Savings Bank of Ansonia . . . **Philip H. Dreissigacker,** '37, vice president and technical director of the Farrel Co., appointed vice chairman of the 1978 Valley United Way campaign . . . **Richard S. Millman,** '66, associate professor of mathematics at Southern Illinois University — Carbondale, appointed by the University's president to be his assistant for the next year as a full-time intern.

Frank Kennett, Jr., '49, elected to the board of directors of the National Council of Architectural Registration Boards . . . **Richard Cahaly,** '60, corporate environmental programs director for Polaroid, appointed to the New England Regional

D. G. Quillen

Commission's hazardous waste advisory group . . . **F. Thomas Westcott,** '46, president and treasurer of Westcott Construction Corp., elected secretary of the Associated General Contractors of Massachusetts . . . **Gordon B. Pye,** Ph.D. '55, elected a senior vice president of the Irving Trust Co. He will serve as manager of the bank's economic research and planning division.

Kudos: Honors, Awards, Citations

Edward R. Hermann, S.M. '49, professor of occupational and environmental medicine at the University of Illinois Medical Center, honored with a Merit Award by the Chicago Technical Societies Council . . . **Kenneth A. Roe,** '41, awarded an honorary Doctor of Engineering degree from the Stevens Institute of Technology. He was cited for his "career-long dedication to solving America's energy problems and environmental needs and his unswerving commitment to professional and academic achievement." . . . **Nathan Cohn,** '27, has received the 1978 Scientific Apparatus Makers Association award.

To Professors **Hale V. Bradt,** Ph.D.'61, and Walter H. G. Lewin of the Department of Physics, N.A.S.A. Exceptional Scientific Achievement Medals for their work on the High-Energy Astronomy Observatory satellite . . . to **Cecil E. Hall,** Ph.D.'48, formerly Professor of Biology, an honorary Doctor of Science degree from the University of Toronto (presented in August during the Ninth International Congress on Electron Microscopy in Toronto) . . . to **Harold ("Hatch") Brown,** Sailing Master, Boston University's Harry Cleverly Award for distinguished collegiate coaching . . . to **Kent F. Hansen,** '53, Professor of Nuclear Engineering, the American Nuclear Society's Arthur Holly Compton Award "for outstanding contributions to education in nuclear science and engineering . . . to **Cecil H. Green,** '23, Life Member Emeritus of the Corporation, the Maurice Ewing Medal of the Society of Exploration Geophysicists for "tremendous contributions to the geophysical profession . . . particularly geophysical education." . . . to **Lawrence B. Anderson,** '30, Dean Emeritus of School of Architecture and Planning, the Joint Award for Excellence in Architectural Education of the Association of Collegiate Schools of Architecture and the American Institute of Arthictects . . . to **Florence Ladd,** Assistant Dean of the School of Architecture and Planning, Honorary Membership in the American Institute of Architects.

Har Gobind Khorana, Alfred P. Sloan Professor of Biology and Chemistry, named to the Pontifical Academy of Sciences.

To **Mark Smith,** '78, a post-graduate fellowship of the National Collegiate Athletic Association for his exceptional performance as a fencer.

Walter P. Frey, '56, an executive with Mobil Oil Co., New York, who has been a faithful supporter of M.I.T. In the Greater New York area for more than 12 years, is now General Chairman of the M.I.T. Alumni Center of New York.

Obituary

Edward D. Stone, 1902-1978

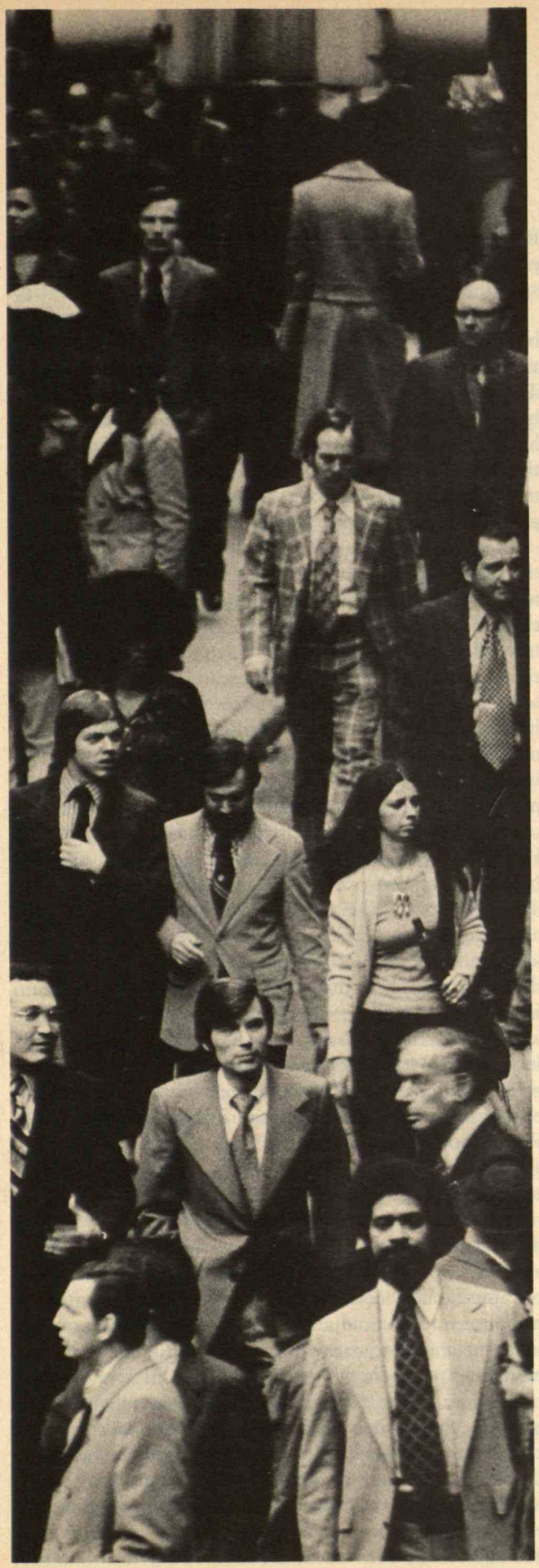
Edward D. Stone, '27, who rose to become one of the nation's eminent architects, died in Roosevelt Hospital, New York, on August 6 after a short illness; he was 76.

Mr. Stone studied architecture at Harvard and M.I.T., and he left M.I.T. with a Rotch Traveling Scholarship which assured him of two years of expense-paid travel abroad. That was when he first learned modern architecture, and he returned in 1929 to design the interior of Radio City Music Hall and to follow this with a number of other distinguished projects in the austere, modern mold. Then in the 1950s came an abrupt return to a more ornate, romantic style which

characterizes most of Mr. Stone's large, well-known projects: the American Embassy in New Delhi, the U.S. Pavilion for the Brussels World Fair, the Kennedy Center, the New York Cultural Center, and the General Motors Tower in New York.

Deceased

Raymond E. Drake, '08; May 4, 1978; P.O. Box 246, Monument Beach, Mass.
William R. Heilman, '08; August 2, 1978; Westminster Village, Highway 31 South, Greenwood, Ind.
Mayo D. Hersey, '09; September 5, 1978; 18 Medway St., Providence, R.I.
George J. Chambers, '12; 1973; 31 Ketchum Pl., Buffalo, N.Y.
Harold G. Manning, '12; July 30, 1978; Hickory Hall Rest Home, 280 Middle Rd. Tpke., Woodbury, Conn.
Francis H. Achard, '13; September 14, 1978; 74 Warren St., Newton, Mass.
Deoch Fulton, '15; May 3, 1978; R.F.D. 2, Ellsworth, Maine
Clarence W. Hale, '15; July 17, 1978; 226 Converse St., Longmeadow, Mass.
Ralph E. Forsyth, '16; July 14, 1978; Box 663, Pocasset, Mass.
Joseph L. Calabro, '17; September 2, 1978; 19 Neponset Rd., Quincy, Mass.
Benjamin H. Sherman, '19; August 13, 1978; 2330 Orrington Ave., Evanston, Ill.
Alexis R. Wiren, '19; August 26, 1975; Fornaluix Mallorca, Beleares, Spain
Edwin S. Burdell, '20; August 30, 1978; 521 Dommerich Drive, Matiland, Fla.
Carl E. Carlson, '20; June 29, 1978; Box 3777, Baytown, Tex.
Mrs. Elisabeth W. Jackson, '21; April 29, 1978; 303 Darlington Rd., Havre de Grace, Md.
Alexander J. LaPointe, '21; July 3, 1978; 690 Hanna St., Birmingham, Mich.
William Thompson Smith, '21; March 16, 1978; 25 Rockwood Dr., Larchmont, N.Y.
Roy A. Wehe, '21; July 31, 1978; 51 El Cerrito Ave., San Mateo, Calif.
J. van H. Whipple, '21; August 22, 1978; 10600 La Reina Ave., Downey, Calif.
Arthur J. Frappier, '22; 1972; c/o James Nigley, 506 Claflin Ave., Mamaroneck, N.Y.
Maxwell B. Donald, '23; January, 1978; Rabbit Shaw, 6 Stagbury Ave., Chipstead, Surrey, England
Fernando de la Macorra, '23; August 8, 1978; Paseo de la Reforma, No. 2546, Mexico
Maurice M. Weiner, '25; July 22, 1978; 66 Viden Rd., Quincy, Mass.
Edward D. Stone, '27; August 6, 1978; 166 E. 63 St., No. 32, New York, N.Y.
Richard B. Rubin, '28; August 12, 1978; 11 Yorkshire Rd., Dover, Mass.
Alfred N. Lawrence, '29; June 8, 1978; Breezy Way, Lawrence, N.Y.
Wallace E. Niles, '31; December 22, 1977; 2120 Harbor View Dr., Dunedin, Fla.
Charles H. Thumm, '33; December 4, 1977
Lawrence Kanters, '36; July 25, 1978; 5212 Malibu Dr., Edina, Minn.
Carl Olson, '36; August 30, 1978; 25 Boswell Rd, Reading, Mass.
William H. Austin, '37; July 1, 1978; 52 Far Horizon Dr., Cheshire, Conn.
George W. Ewald, '37; April 23, 1978
Carl H. Abel, '38; August 2, 1978; 6309 E. 57th Pl., Tulsa, Ok.
Robert D. Flynn, '38; August 14, 1978; 86 Sussex Dr., Manhasset, N.Y.
James S. Rumsey, '40; August 14, 1978; Box 3719, Wilmington, Del.
I. Earl Meyers, '41; August 10, 1978; 29 Goddard Cir., Brookline, Mass.
George E. Power, '41; July 2, 1978; 355 Circlewood Ln., Cincinnati, Ohio
Sabaheddin M. Fenmen, '42; August 1, 1978; 19/15 Vali Dr., Resit C. Ciankaya, Ankara, Turkey
Mehmed A. Kozak, '42; August 1, 1978
Corwin H. Brumley, '44; July 9, 1978; 1 High Meadow, Penfield, N.Y.
Ali C. Isinal, '44; August 1, 1978
Muzaffer M. Kaci, '44; August 1, 1978
Mehmet A. Tara, '44; August 1, 1978
Cemal A. Uluant, '44; August 1, 1978
Feyzi M. Unel, '44; August 1, 1978
Ali M. Utkan, '44; August 1, 1978
Serif Oskay, '45; August 1, 1978
Oliver W. Hamilton, '47; June 27, 1972; 1227 Agincourt Rd., Ottawa, Ont., Canada
Joel M. Orloff, '78; September 3, 1978; 1181 Lincoln Ave. South, Highland Park, Ill.



These impairments affect virtually every body system — sensory, motor, skeletal, renal, cardiovascular, respiratory, etc.; and within each system they include a wide range of specific losses representing partial or total dysfunction. For example, losses in the motor system may result from amputation or paralysis, among the latter being such relatively modest problems as impaired use of one foot following cerebral stroke. Multiple impairment within one individual is not uncommon, as in the example of the deaf-blind. Thus the large numbers of the disabled include some overlapping disabilities in many combinations and extents of impairments.

Improved nutrition and sanitation, the use of antibiotics to control infectious diseases, and more sophisticated medical and surgical procedures have reduced infant mortality and increased life span, and these trends will surely continue. The problems of disablement have accordingly increased. Medical science can now save infants with defects which would heretofore have been fatal, and the extension of longevity has increased the incidence of those dysfunctions inevitably associated with aging. Furthermore, our technological, mobile, permissive society exposes us to many hazards. These include those of transportation and recreation as well as the results — which we are only beginning to understand — of environmental interventions involved in producing energy, food, and other industrial products. Despite significant advances in scientific knowledge and medical treatment, a decrease in the incidence of disablement is unlikely. If anything, we must expect the opposite.

The demographic dilemma, which begins with the paucity of raw medical data, is compounded by our failure to define dysfunction, impairment, and handicap. For purposes of this article, *impairment* is the consequence to an individual of a biological *dysfunction,* whether imposed by accident, therapy, or natural causes. *Handicapping* (or disability) occurs as an individual who is a victim of impairment relates to the environment and to other persons and society in the daily activities of self-care, work, and play.

Medical records clearly categorize dysfunctions, but the consequences in terms of subsequent impairments are seldom made clear: medicine as a profession is not usually involved beyond the acute or episodic phases of diagnosis and treatment. Inferring handicap from either dysfunc-

tion or impairment is even more hazardous.

For a classic example of this problem, consider the incongruence between these two estimates: the Department of Health, Education and Welfare proposes that 13 million Americans suffer a bilateral hearing loss of sufficient severity to interfere with their ability to understand speech; but the Urban Mass Transportation Administration estimates that only 350,000 people are denied access to urban mass transport because of hearing deficiencies. Such a discrepancy can be explained in part by the way in which hearing statistics are compiled, some based on objective audiometric measurements and some on behavioral questionnaires. U.M.T.A.'s lower estimate presumably also reflects the facts that not all Americans live in cities with mass transit and those who do vary in their occasion to use it; U.M.T.A. may also have made some arcane judments on *how* hearing loss affects access to bus and rail transportation.

Handicapping conditions are almost always irreversible, frequently but not necessarily chronic, and not usually life-threatening. Most handicapped persons live life spans which are close to normal. The true dimensions of handicapping, whether viewed from the individual's or society's perspective, must include this longitudinal consideration; statistics on handicapping must encompass the economic and social costs of lifetimes of impaired capability. This concept that illness should be measured in terms of its social burden is beginning to gain acceptance, and we are now seeing data for diseases showing such dimensions as potential years of life lost, days in hospital, physician office visits, lost work days, limitations of major activity, and total economic costs.

But such data are not yet used to assess the burden of disabilities and handicapping conditions. So we must rely on other ways of measuring the national social cost of handicaps: the present costs of disability payments through Social Security, pensions, and other programs are $114 billion annually; 2 million of the severely disabled are home-bound, and nearly that many are in institutions; the incomes of severely disabled people average half those of the able, and some 4 million disabled have incomes below the poverty level; whereas 30 per cent of the nondisabled national population has attended college only 9 per cent of the severely disabled has.

A New Activism for the Handicapped

But as we move to collect better demographic data and reckon more accurately the true cost of handicapping conditions, we must not let a preoccupation with numbers deflect our attention from the needs of the individual impaired person and the personal losses and tragedies involved when we fail to meet those needs. The abiding focus must be on the individual human being — on that person's own need to realize native, latent potential despite the handicap, and on society's responsibility to help.

Partly through their own efforts, the handicapped are becoming more visible, and we are witnessing more vigorous and effective action by them and on their behalf. The voice of agencies for and of the handicapped is now becoming more coherent, focused, and effective. The handicapped themselves deserve the major credit for the recent promulgation of federal regulations which mandate their "equal access" to educational institutions and employment opportunities.

Two successive Panels on Research Programs to Aid the Handicapped have emphasized the need for new technology, including applications of systems spawned by the national space program and other advanced technologies. Both these Panels have emphasized that federal expenditures in pertinent research and development have been "far too small"; in 1976, while at least $21 billion was used for rehabilitation services and outright financial assistance to the handicapped, research and development on their behalf was only $31 million — 0.15 per cent of the total, just under $3 per disabled person.

The recommendations of these Panels, of the White House Conference on Handicapped Individuals, and of a National Academy of Sciences study of Science and Technology in the Service of the Physically Handicapped are reflected in the Comprehensive Rehabilitation Services Amendments of 1978 and in other legislation before the Congress. The principal thrust of these proposals is to focus research and development on human rehabilitiation in a new institute modeled on, but not in, the National Institutes of Health, located in the proposed new Department of Education or in the current venue of the Rehabilitation Services Administration. The National Science Foundation has been directed to develop a research program in this field, and the Veterans Administration is reorganizing its program.

In conventional medical diagnosis and clinical care, the drama of the emergency, of massive intervention through surgery, and of rapid changes in patients' condition compel attention. By contrast, treatment and rehabilitation in response to chronic disabling conditions is likely to be a long, melancholy process dealing with the reality of permanent impairment while stressing the goal of maximized residual capacity. No wonder, then, that rehabilitation has been the impoverished and distant relative of clinical care. Physicians tend to choose career paths which offer the self-fulfillment of patients returned to health and mobility as well as promise of personal renumeration; rehabilitation has been the arena for paramedical people. Though it has been certified since 1968, rehabilitation

medicine is practiced by only 0.44 per cent of the 344,000 physicians in the U.S., and most of these practitioners are graduates of foreign medical schools.

The New Era of Technology for the Disabled

The relationship between medicine and engineering in dealing with chronic disabling disease has been molded by this same neglect; in general, the impact of technology has not been nearly so visible or effective in rehabilitation as it has been in conventional clinical care. The only exception to this has been in the case of casualties of war. Flurries of activity in behalf of the handicapped following the Civil War and World War I in the U.S. resulted in a very rudimentary prosthesis technology, with results not extending much beyond hand-carved wood extremities. Following World War II, as part of his effort to convert the Office of Scientific Research and Development into civilian activities, Vannevar Bush encouraged high-technology firms previously engaged in such pursuits as military aircraft and radar to turn their talents towards creating prostheses and mobility aids for the blind. But oversophisticated technology and primitive understanding of human need yielded essentially no useful outcome.

The gulf separating engineering from the problems of the handicapped persisted for at least another decade. The modest but significant armamentorium of devices which now give handicapped individuals opportunities for more normal life experiences and for participation in society stem only from work arising in the late 1950s and the early 1960s.

Consider, for example, our slow progress through three stages in utilizing the technologies of digital computation and optical character recognition, leading to a revolution in creating printed material for the blind. Prior to the 1950s braille, adapted from a tactual code originally devised for night-time direction of military artillery, required sighted translators and cumbersome, slow embossing processes. In the 1960s this translation process was automated: printed matter can now be scanned and rendered automatically into braille, greatly reducing the time required for translation and thus giving the blind far more timely access to printed material in braille form. But braille itself is cumbersome, and a more significant recent development is one which reduces dependence on its use by giving direct access to the printed page to men and women with severe visual impairment. This is the very successful OPTACON, a portable device the size of a cassette recorder; when the blind user scans printed material with a tiny camera employing solid-state optoelectronics in one hand, a vibration characteristic of each printed character encountered by the camera is felt against the finger of the opposite hand inserted into the device. With training, reading speeds of up to 100 words a minute are possible.

Still more efficient means of information acquisition for the blind are now being developed to capitalize on the efficiency of speech itself. Optical character recognition devices are now being coupled with computer-based synthetic speech generators to make possible true reading machines for blind people: words are scanned automatically, and sounds characteristic of the letters and groups of letters are automatically generated as synthetic speech.

A similar development is leading to ever-more-effective technology applied to problems of the disabled. The blind traveller used to depend exclusively upon a long cane, a guide dog, or a sighted human to assure that his or her next step would be a safe one. Now, thanks to the tenacity of several researchers studying ultrasonic electronic means of exploring the environment, hundreds of the blind world-wide are being given information which extends their mobility strategy to their next several or even a dozen steps.

The PATHSOUNDER, worn about the neck like a camera, acts as an ultrasonic radar: it remains silent in the absence of echoes from would-be obstacles, indicating a clear path. But when an obstacle reflects the PATHSOUNDER's pulse, an audible or vibratory warning signals the presence of the obstacle and indicates its distance. The same principle has now been further exploited in SONIC GUIDE, in which two ultrasonic elements mounted to the left and right of the nose bridge on an eyeglass frame. The ultrasonic echo of an object is presented to both ears but is loudest in that ear nearest the object, and the blind person can invoke his or her inherent binaural sound-localization ability obtain directional information about the reflecting hazard. Range is coded into the frequency of the perceived signal, and even the reflection characteristics of each object are discernable as the presence or absence of complex overtones on the primary range signal. For example, a planar reflector such as a plate glass window provides a pure tone, and diffuse reflectors such as trees, fences, etc., result in characteristic, identifiable sounds. Thus the blind user is offered a rich, audible orchestration of the spatial surround.

Help for those handicapped by impaired hearing became really practical when solid-state electronics made possible very small appliances with low power consumption. Now there are countless forms of small hearing aids for those who require amplified sound. For the profoundly deaf, devices which stimulate the skin with either mechanical or electrical vibrations can provide some auditory input.

Interesting experiments are being conducted on hearing-deprived infants and children who, as a result of

their loss, never acquire natural speech. The research problem is to devise some spatial-temporal tactual display which can communicate speech patterns. Although this goal remains to be achieved, our growing capability in using computers to organize and process data for systematic human interaction and to replicate human communication systems will undoubtedly lead to important future developments.

Building Feedback into Prostheses

Computer-based simulations of human systems have already proved themselves in research on prostheses for upper and lower extremities following amputation. The feasibility of using minute electrical signals from remnant muscles in the amputee's stump to control an electromechanical elbow was first demonstrated in the BOSTON ARM; the concept was proved in advance of development by computer simulation. The research, and later the successful application of the prosthesis itself, demonstrated that in all cases, however fragmented or atrophied they are, the relevant muscular fragments are still under control of the brain. The signals they provide are adequate, with electronic magnification, to connect the brain's intent with the machine's response. Thus the amputee's control of his elbow prosthesis is "natural"; research versions of the device include detectors and feedback circuits which inform the amputee of the angle of his elbow and heighten his sense of the load in his artificial hand.

The BOSTON ARM replicates only one of the movement capabilities lost by an above-elbow amputee. More complex upper-extremity prostheses which replicate rotation of the wrist and of the arm itself about the axis of the upper arm, as well as elbow flexion, have been developed and are now under evaluation. The problem is rendered complex by several factors — the low total weight which the amputee can tolerate, the limitation of volume — for cosmetic reasons — to that of the natural limb, and the complexity of the motions to be replicated. These make necessary extremely sophisticated and compact electromechanical designs and efficient energy storage and utilization.

But by far the most difficult problem is devising a human/machine interface which can detect authentically the human's intent and reflect this accurately in the machine response. For the single-axis BOSTON ARM elbow, detecting the activity of a single pair of antagonistic muscles is adequate. Control of the three-axis UTAH ARM, the more complete upper-extremity prosthesis, requires detection of myoelectric activity at ten locations in the shoulder, back, and chest overlying the muscle systems which collaborate in the several motions. Then these muscle signals must be played into a computer model of the natural musculature to yield appropriate commands to motors which control wrist, elbow, and arm motions.

The SWEDISH HAND is a forearm-and-hand prosthesis with a similar control strategy to provide wrist rotation and flexion along with several modes of finger flexion and thumb rotation. In this case, some of the musculature needed to control the hand is missing, so a "learning" process is required of both amputee and prosthesis. The residual musculature of the amputee's forearm is first made to interact directly with a pattern-recognition program in a free-standing computer; in turn, the computer output drives the several actuators of the wrist and hand. With the prosthesis in view of the amputee, he is asked to attempt patterns of muscular activity appropriate for a motion — say wrist flexion or rotation. His observation of the prosthesis response reinforces his own appropriate muscular activity. When the proper combinations of electrode locations and muscular activities are identified, the pattern-recognition design is transferred from the computer to a physical electronics package for incorporation into the prosthesis.

Rehabilitation following paralysis, hemiplegia, and paraplegia (loss of the use of two extremities), and quadraplegia poses somewhat different problems from that following amputation, since in these cases the affected limbs are still intact, albeit partially or wholly immobilized and probably uncontrollable. A common solution is the use of an external supporting orthotic frame with a powered actuator. Functional Electrical Stimulation (F.E.S.) of the otherwise useless muscular tissue, a strategy which — like those previously discussed — capitalizes on the residual nervous system, is a less cumbersome and very useful alternative.

Electrical impulses applied to electrodes on the skin over the point where a nerve enters a muscle, or needle electrodes actually in contact with the muscle, are used to cause muscle contractions somewhat similar to those originally invoked by the physiological nerve signals. When a desired motion is not demanding, as in residual "drop foot" following hemiplegia, F.E.S. can be useful indeed, providing the stroke victim with improved gait. A stimulator worn on the patient's belt receives its signal from a heel-switch transmitter and broadcasts a tiny impulse to an implanted receiver connected to an electrode on the peroneal nerve, causing muscle contraction and foot dorsiflexion. More complex versions of this approach, which will stimulate major muscles around the hip in an appropriate sequence, are being explored as an approach for restoring walking to the paraplegic. The problems to be resolved are substantial. Even massive stimulation of muscle cannot produce maximum con-

traction and leads to early fatigue; the use of several electrodes in each muscle, each stimulated in sequence, can improve muscle performance. At the same time, the relationships between the several muscles involved in walking must be preserved, and the synergistic cooperation of the many muscle groups around the several joints must be achieved. Beyond this, the problems of stability must be successfully addressed if the patient is to be able to walk safely without assistance.

Engineering in the Medical Environment

Two issues are at stake in bringing effective prosthesis to more and new classes of users. One represents the unfinished business of research and development — the basic need for new technology. The other is the problem of how to bring successful prototype prostheses from laboratory curiosities into practical, commercial devices available at acceptable prices. This represents a major problem in technology transfer which must be recognized and solved. *Ad hoc* solutions are sometimes successful; examples include computer-translation programs for braille disseminated through commercial computer networks and the development and manufacture of the BOSTON ARM by an insurance company.

Fortunately, the field of rehabilitation and prosthetic devices is beginning to attract serious entrepreneurs who are establishing responsible enterprises devoted to making a fair profit through the manufacture and distribution of aids for the handicapped. The most notable of these to date is Telesensory Systems, Inc., producers of the OPTACON reading machine and a SPEECH PLUS "talking calculator."

Other companies are making equally important contributions by creating employment opportunities for the handicapped — for example, by installing nonvisual switchboard positions for blind telephone operators using braille and/or spoken displays instead of flashing buttons and visual alphanumerics. But at best handicapped people are likely to be under severe economic constraints; despite improving employment opportunities, few are able to buy expensive prostheses and then invest time and effort in learning to use them. Means must be found to partially subsidize the production of useful rehabilitation products and/or to help those who need such products acquire them; either or both should become an accepted part of health care costs. Health insurance payments should be broadened to include the cost of rehabilitation devices and of the training necessary for their use, both being natural sequels to medical diagnosis and treatment.

Another requirement for optimum rehabilitation is close collaboration between physician and engineer in searching for the optimum combination of treatment and prostheses which will maximize recovery of the individual patient's functions. A few examples will suffice to make clear the importance of this "team" concept. In fitting an artificial limb (prosthesis) to an amputee, the knowledge and skills of the orthopedic surgeon in physical medicine and rehabilitation complement the engineer's knowledge of biomechanics, kinematics, materials, and fabrication. Or when severe quadraplegia or other neuromuscular defects deprive an otherwise intelligent person of the ability to communicate verbally, then a communications engineer and an occupational therapist can help set rational priorities among the several different needs. In countless cases such as these, the participation of a rehabilitation engineer with the medical and paramedical staff in the various clinics — amputation, scoliosis, hemiplegia, etc. — provides valuable perspectives on the patient's difficulties. Sometimes this leads to an improved diagnosis, and almost invariably it leads to a more satisfactory clinical and rehabilitative solution. Current medical knowledge and contemporary technology can thus be brought together so that each reinforces the other.

Having said this, however, I must note that physicians are minimally, or not at all, involved in large areas of rehabilitation. These are cases where the patient's condition has been stabilized by a physician's diagnosis and treatment, when subsequent rehabilitation is placed in the hands of physical and occupational therapists and mobility, orientation, and communication specialists. The engineer's role is then dominant during the conception, realization, and adaptation of appropriate prostheses. (But sometimes these steps are made almost too simple, and engineers are hardly involved at all; most deaf people obtain rehabilitation assistance, if at all, from an audiologist or, more likely, a hearing aid salesman.)

Whenever it occurs, the involvement of an engineer in close synergistic relationship with a physician or a paramedical worker in a health-care facility can and does lead to the identification of research opportunities which might not otherwise be apparent. Thus the interaction of medicine and engineering is not limited to direct patient services. The intellectual approach of the engineer, based on his understanding of the physical sciences and mathematics, is uniquely valuable in collaboration with the biological, anatomical, and behavioral knowledge of the physician and even of the paramedical specialist. The result is invariably new concepts and directions for research in rehabilitation.

Such situations typically lead to emphasis on patient-centered adaptations of existing devices or concepts. These are obviously important and valuable, but longer-range, more generalized research must be undertaken if basic changes in prostheses and rehabilitation systems are

to be made in the future. The OPTACON and cybernetically-linked replacement limbs such as the BOSTON ARM represent the fruits of such basic research. Unfortunately such generalized studies bringing medicine and engineering together have not in the past enjoyed very high priorities in the planning or funding of rehabilitation work.

One reason for the inadequate support of fundamental rehabilitation research is its enormously broad interdisciplinary range. Consider, for example, the very persistent need for cross-sensory modality transfer following the loss of one or another of a human's sensory capabilities. The blind can only hear or feel; the deaf can only see or feel; the amputee can no longer sense movement in the missing limb. In all such cases, the lost spatial, communicative, or kinesthetic sense can only be transmitted through one of the remaining senses. In the case of blindness, for example, the real rehabilitation research question is: How can spatial information normally perceived through a three-dimensional, color-sensitive, high-resolution system of eye and brain be restructured so as to be optimally presented to the auditory mechanism or through the limited dynamic range of the skin sense? Or consider another important dimension of this interrelationship of the communicative sense: How does human development relate to rehabilitation? We know that the congenitally deaf child is at great disadvantage because hearing deprivation robs him of the natural acquisition of language. Could special visual and/or tactual information imparted to that child during the years when language skills would naturally develop accelerate the child's use of language or make it more adequate?

Many other examples of what I call basic rehabilitation research needs could be cited, among them: the need to detect and interpret nervous system activity at many additional points and in other ways to control replacement limbs supplied to amputees; the need to selectively stimulate physiological control centers to reanimate the immobilized; or the need (an even more ambitious, longer-term hope) to stimulate the brain to by-pass deficient sensory organs and achieve substitutes for normal audition, for example, or vision.

A Knee That Meets Its Wearer's Needs

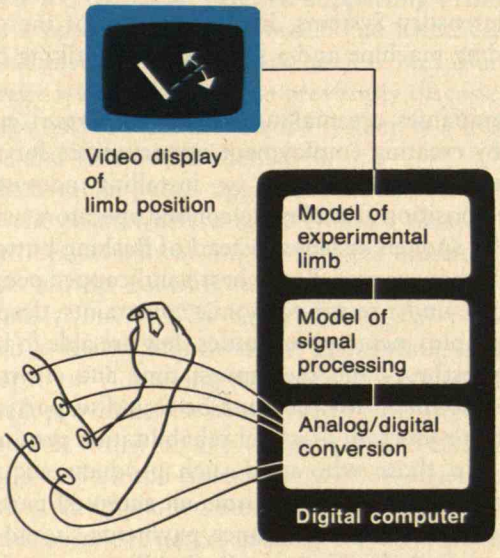
Let me close this article by describing what I believe to be the area of premier potential in such fundamental research on motor and sensory prostheses — the study of man-machine systems.

The underlying question in every case of prosthetics research is how best to relate the residual capacity of a human and the replacement capacity of a machine so that the machine becomes as nearly as possible a natural extension of the human. The machine must be under the human's neural control, and it must be capable of transducing back into the human's sensory system appropriate information about itself and the environment. So many questions must be asked and so many variables optimized in such systems that their study must, in my view, be conducted with computer-based simulations which involve potential prostheses and human users. In this way many

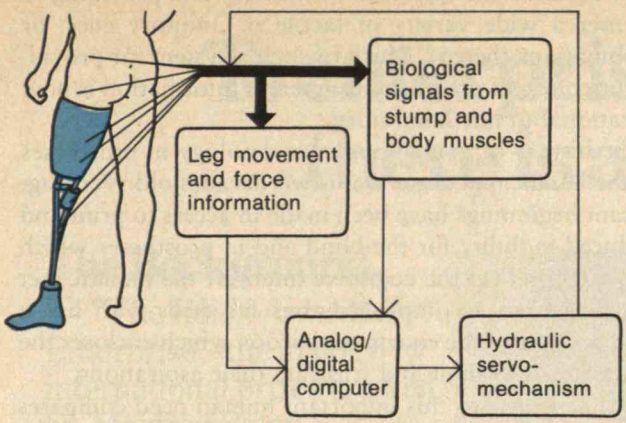
Matching Humans and Prostheses by Computers

One of the underlying problems in prosthesis research is how best to relate the residual capacity of the human to a machine so that the machine becomes a natural extension of the human, under his control, responding much as the missing limb would have, and capable of transducing back into his sensory system appropriate information about the environment and the machine's place in it. So many questions must be resolved — and so many variables optimized — in research on such devices that it proves desirable and even necessary to study the relationship between man and hypothesized prosthetic aids in a computer-based simulation. With such a system many signal processing combinations and many different limb characteristics can be evaluated against both objective and subjective criteria as the human interacts through the computer with a generalized prosthesis. The computer simulates important aspects of possible future devices, reducing the need for hardware in the exploratory phase. This design concept has been successfully used in the development of two prostheses at M.I.T., and its use continues in studies of new devices and systems.

The BOSTON ARM *(below)* was the first device developed through such a computer-based, man-machine analysis. It was in fact the first practical demonstration that biological signals emanating from the brain, intended for a now-amputated limb, can be detected in the stump and used to



control an artificial elbow in a natural manner with virtually no training. The diagram shows the man-interactive simulation system used in the initial research. Data from electrodes over the remnant muscles in the upper arm are converted into digital signals; the computer's video display shows the limb's



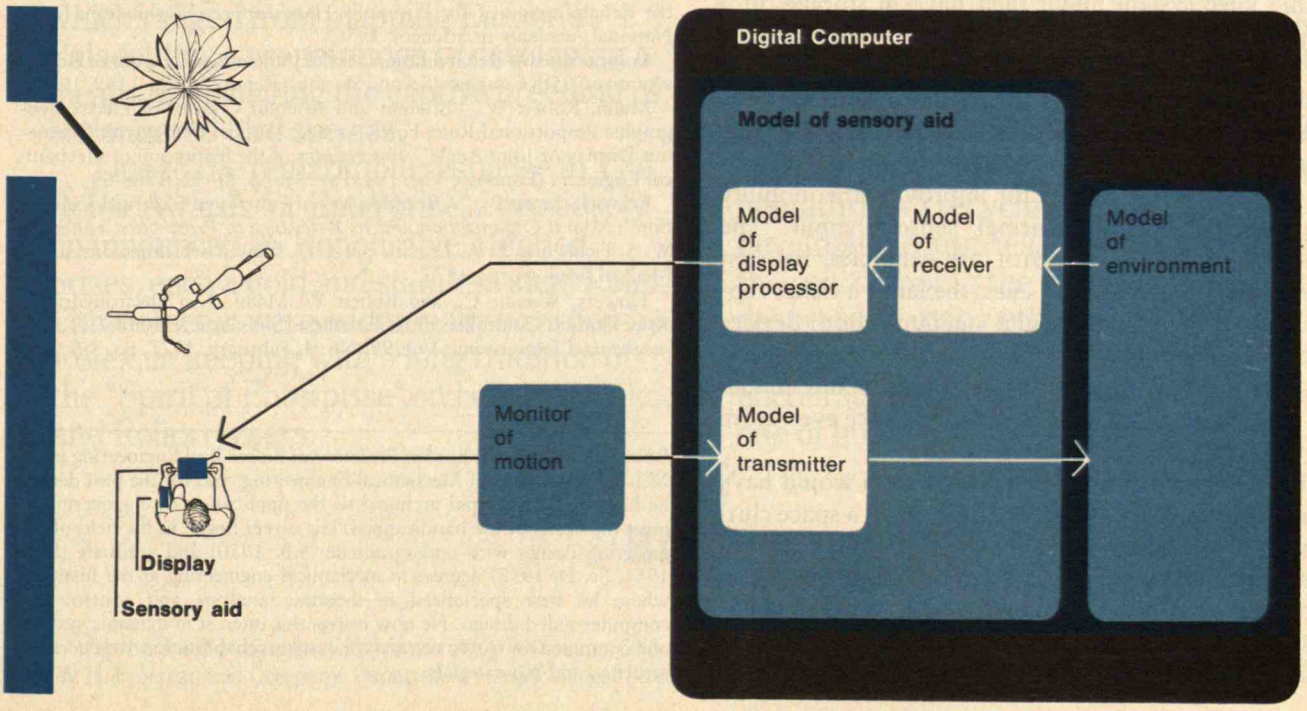
response for various different signal processing and device configurations. When the optimal control strategies were identified with this simulation system they were adopted for the first BOSTON ARM prototype.

The same concept is now being used in developing a naturally-controlled adaptive knee joint *(above)* for lower-extremity prosthesis. A high-performance electrohydraulic servomechanism at the artifical knee permits passive or active knee-joint movement under the control of signals received from the biological sources in the amputee and physical transducers in the prosthesis, the two being combined in a computer. The goal is to achieve such a combination of biological and physical control that the characteristics of the knee joint will be variable in accordance with the user's needs, adapting the knee's movement to different cadences and to the demands of ramps and even stairs, providing flexion during stance, and perhaps even responding to such unexpected events as tripping. A future wearable system might have in storage in a microprocessor information on knee torque versus angle profiles for each of a number of such different modes of activity. An intent-recognition scheme drawing signals from the amputee's stump would select the appropriate mode with little or no overt effort on the part of the user, and a built-in electronic system would produce the knee profile appropriate to the user's next movements.

Radar-like systems utilizing ultrasound are now available to extend the mobility of the blind, augmenting their long canes and guide dogs. But the repertoire of information which such an ultrasonic radar can obtain is far greater than our capability for transmitting it to the blind traveller; and now the same concepts for computer-simulation are being applied to the study of sensory aids which would present more information in more useful formats to blind users.

A digital computer system compares the movement of a human subject with a map of an environment through which the human is moving, in this case *(below)* a space containing a bicycle and a tree. The reflection "signatures" from these two hazards are very different — the tree is a soft, unfocussed obstacle, the bicycle a sharp, narrow, linear one; the tree is fixed in position, the bicycle is probably moving; the bicycle is just ahead, the tree further away, off to the right. With this information the computer can produce commands for various forms of sensory input which are telemetered to a display on the subject. With a system such as this a much richer variety of acoustic and sensory cues can be explored and evaluated than could ever be achieved by designing, building, and testing specific concepts one by one.

And when the optimum display systems are determined, the specific functions needed to provide them can be built into a miniaturized unit which can become part of a portable mobility device.



variations of signal processing and limb characteristics can be evaluated, against both objective and subjective criteria, as the human interacts with a generalized limb; and all this can be done before a commitment is made to any particular hardware.

The group in our laboratory is currently using this strategy in exploring several concepts for biologically-controlled lower-extremity prostheses, in particular an adaptive knee joint.

The natural knee exhibits many different patterns of muscular activity during walking; movement and rhythm on level terrain are very different from those while going up a ramp or down a stairway, for examples. An unexpected event, such as tripping, elicits yet another mode of behavior. A goal of our research is to give an artificial knee a repertoire of trajectories to emulate these natural functions appropriate for each mode of activity. We employ a high-performance electrohydraulic servomechanism in the prosthetic knee joint to permit passive or active movement on the basis of signals received from the user's body combined in the laboratory computer with those received from the artificial leg below the knee. Such an arrangement permits changing the characteristics of the knee joint almost continuously, even during a single step, just as man himself does — adapting the period of the leg to different cadences or providing flexion during stance to reduce the vertical movement of the body's center of gravity, thus reducing the metabolic cost of walking.

To switch from mode to mode, a scheme to recognize biological intent, in principle if not in detail similar to those previously decribed in the UTAH ARM and the SWEDISH HAND, observes the activities of muscles above the knee. This biological data combined with information transduced from the artificial leg produces in the computer a distinguishing characteristic of the mode change, thus conveying the amputee's intent to the knee mechanism without any overt effort on his part. A future wearable knee system might then have in storage, in a microprocessor, the various knee motion profiles for each activity; an on-board electronic system would define the knee motion appropriate for a particular situation.

This concept for prostheses which interact with their users to automatically simulate normal function should apply equally well to devices for improving the mobility of humans deprived of normal sensory input. The PATHSOUNDER and SONIC GUIDE are examples, the first producing deliberately simple cues, the latter a richer representation of the environmental surround. Both devices have enthusiastic users, but it is clear that an enormous range of other ways to simulate the auditory and tactual senses need to be explored in order to produce even more effective surrogates for lost vision.

To be authentic, such a simulation system would have to permit free mobility of the human through a space cluttered with obstacles by providing many forms of natural nonvisual stimuli — echoes, air drafts, odors, etc. — to the traveller. An ideal computer-based system would make possible a systematic, yet objective, search of the user's solution space, comparing the physical characteristics it detects with models in its memory and providing to the user a wide variety of tactile or auditory cues, or combinations thereof. Much of such a system for providing a rich repertoire of environmental information is now operational in our laboratory.

The history of contemporary technology in prostheses for the handicapped is a scant two decades old. Very significant beginnings have been made in access to print and enhanced mobility for the blind and in prostheses which adequately reflect the cognitive intent of the human. Yet what has been accomplished thus far deals with but a small portion of the enormous cocoon which encloses the handicapped to limit and frustrate their aspirations.

Our response to this important human need compares most unfavorably, in both sophistication and comprehensiveness, with our scientific advances in medicine and our technological progress in space or weaponry. But there are promising signs that as a society we are beginning to hear and respond to the legitimate needs of the handicapped. With ever-more-sophisiticated design and guided by growing knowledge of physiology, communications, and the man-machine interface, we are beginning to bring to handicapped people the near-normal human capabilities they need and deserve.

For Further Reading

Mann, Robert W., "Technology and Human Rehabilitation: Prostheses for Sensory Rehabilitation and/or Sensory Substitution"; *Advances in Biomedical Engineering*, Vol. 4, pp. 209-253. New York: Academic Press, Inc., 1974.

Sheridan, Thomas B., and Robert W. Mann, "Design of Control Devices for People with Severe Motor Impairment"; *Human Factors*, Vol. 20, No. 3, 1978, pp. 321-338.

Rice, Dorothy P., Jacob Feldman, and Kerr L. White, "The Current Burden of Illness in the U.S." Washington, D.C.: Institute of Medicine, National Academy of Sciences, October, 1976.

"Research Programs to Aid the Handicapped"; Panel Report to the Committee on Science and Technology, U.S. House of Representatives, 95th Congress (Second Session). Washington, D.C.: U.S. Government Printing Office, Serial V, 23-077 0, March 1978.

Science and Technology in the Service of the Physically Handicapped, Summary and Vol. 1; Report of the Committee on National Needs for the Rehabilitation of the Physically Handicapped. Washington, D.C.: National Academy of Sciences, 1976.

Comprehensive Rehabilitation Service Amendment, House of Representatives, 95th Congress (Second Session), Report No. 95-1149, 1978.

Mann, Robert W., "Efferent and Afferent Control of Electromyographic Proportional-Rate, Force-Sensing Artifical Elbow with Cutaneous Display of Joint Angle"; *Proceedings* of the Institution of Mechanical Engineers (London), Vol. 183, Part 3J, pp. 86-92, 1968-69.

Reswick, James B., "A Brief History of Functional Electrical Stimulation"; *Neural Organization and Its Relevance to Prosthetics*, edited by W. S. Fields and L. A. Leavitt, pp. 3-15. New York: Intercontinental Medical Book Corp., 1973.

Flowers, Woodie C., and Robert W. Mann, "An Electrohydraulic Knee-Torque Controller for a Prosthesis Simulator"; *Journal of Biomechanical Engineering*, Vol. 99, No. 4, February, 1977, pp. 3-8.

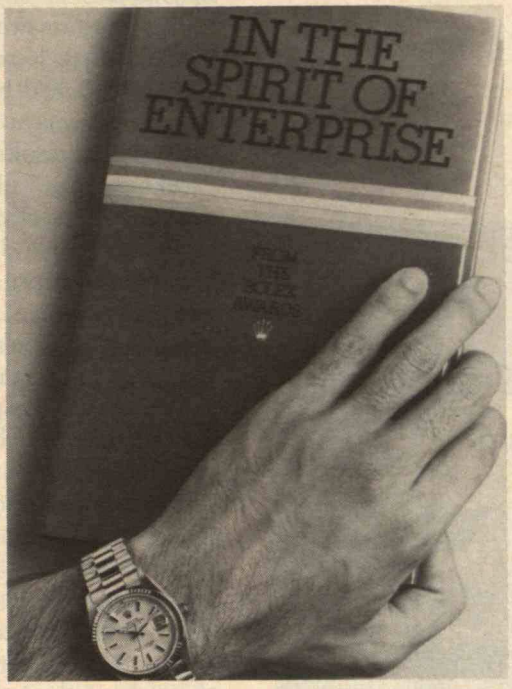
Robert W. Mann is Whitaker Professor of Biomedical Engineering in the M.I.T. Department of Mechanical Engineering, and for the past decade he has been a principal architect of the application of engineering to meet the needs of the handicapped. His career began in the field of engineering design with undergraduate (S.B. 1950) and graduate (S.M. 1951, Sc. D. 1957) degrees in mechanical engineering at the Institute, where he first specialized in dynamic analysis and control and computer-aided design. He now brings this interest in dynamic systems and computer control to research on human rehabilitation, degenerative arthritis, and biomaterials.

To enterprising individuals, there is a book for you.

The Background.

"The Rolex Awards for Enterprise"–the major, new international prizes created by Montres Rolex S.A. of Geneva to encourage the "Spirit of Enterprise" in individuals around the world by rewarding outstanding personal efforts or contributions in selected categories of human endeavour.

Applications were accepted in the areas of Applied Science and Invention, Exploration and Discovery, and The Environment.



A distinguished Selection Committee was assembled to assess the thousands of projects received.

In March 1978 the first five Rolex laureates, four men and a woman, were granted awards of 50,000 Swiss francs each plus gold Rolex Chronometers for projects which ranged from mapping Europe's Palaeolithic cave paintings to developing a means of managing the captive breeding of endangered bird species.

Due to the remarkable response to The Rolex Awards for Enterprise, a previously unannounced 26 Honourable Mention prizes, each a gold and stainless steel Rolex Chronometer, were additionally awarded by Rolex, in keeping with a long tradition of the "Spirit of Enterprise" on behalf of Rolex and Rolex owners.

The Book.

"In the Spirit of Enterprise", by Gregory B. Stone, is a unique, stimulating and unforgettable collection of people and ideas, taken from more than 3,000 applications from 88 countries, which were submitted to The Rolex Awards for Enterprise.

With a foreword by Gerard Piel, Publisher of *Scientific American* magazine, who states, "The ventures proposed in these pages declare the essence of what makes us human," the book will introduce you to 131 enterprising people and projects, including the five Rolex laureates, the 26 Honourable Mention winners, and a host of others.

You will encounter a stunning range of enterprise: searching for the lost da Vinci, diving with killer whales, establishing experimental free states, using wood for bone implants, cancer research using mummies, recording rare jungle sounds, constructing perfect violins, attempting the manned flight altitude record in a "home-made jet plane", miniaturising recycling plants for use in developing countries, growing vegetables on the sea, stopping the encroachment of the deserts and many others.

"In the Spirit of Enterprise" will encourage you to add your own chapter to one of humanity's finest traditions.

ROLEX
of Geneva

"In the Spirit of Enterprise", approximately 380 pages, 60 colour illustrations, hard cover $14.95, soft cover $6.95. Published by W. H. Freeman and Company, Department R, 660 Market Street, San Francisco, California 94104, USA. Or through your book store.

Letter from Peking

Karel Kovanda

Shan Kuei-chang is gone now, most probably in prison, and nobody feels sorry for him. For years he had been the terror of the Institute of Optical and Precision Machinery in Changchun, Kirin Province, Northeast China. He survived the fall of the "gang of four," his spiritual and political patrons, by more than a year — longer than many — but in the new atmosphere permeating China his end was inevitable.

The Institute was created in the early 1950s. It gave China its first electron microscope, and produced a laser a year after it had been first invented. During the 1970s, however, it was not producing much of anything. Achieving research results was considered bad. It amounted to "seeking fame," obviously a most repugnant crime. Interest in basic research, for example, allegedly demonstrated a "triple divorce": from politics, from practice, and from workers and peasants.

Victims of the Cultural Revolution

The situation might sound like a foolish aberration, if it did not have a desperately tragic side to it. It is precisely the tragedies which went with the antics of the "gang of four" which help us understand the depth of accumulated wrath that has since burst forth against its members and followers. In Changchun, Shan Kuei-chang was bent not only on stopping research but also on discovering an enemy spy under every lab table.

His methods for developing "evidence" were so successful that during his heyday they were emulated throughout the province, and he himself was appointed Chairman of the provincial party committee's Science and Technology Commission. Membership cards in scientific and technological organizations were viewed as spy identification cards. Radios and cameras were marked as espionage equipment, and bank savings of research workers as operating funds. People were forced into confessing their "crimes" often under excruciating torture: I was told about beatings with nail-studded planks, sleep deprivation, jabbing needles under fingernails, pouring urine and oil into noses.

Not only scientists and technicians were affected by this witch hunt. A young worker broke something on his lathe, out of carelessness or by accident, and was criticized for "sabotage." Rather than face the "struggle meeting," with thousands of people herded into an auditorium where he would be officially abused, he committed suicide.

The extent of the disruption throughout China was as incomprehensible as the attacks against intellectuals. Teachers, for example, were as a class virtual social outcasts. Mao's dictum that "to rebel is justified," intended perhaps to rouse people from their lethargy against omnipotent bureaucracy, was interpreted as a denial of all incumbent authority, and in particular that of teachers. In colleges and universities, the opposition against old-style examinations, dubbed "surprise attacks," which rewarded mechanical memorizing, resulted in discarding exams altogether — as well as every other check on performance. Actually, one of the meteoric stars on the sky of Cultural Revolution was a character celebrated for

turning in a blank piece of paper at exam time; but unlike Winston Churchill, who once did the same, this young man had nothing else going for him and has since fallen into oblivion as a "political swindler."

Intellectuals were also attacked as a propertied class. Their property — knowledge. Indeed, with the appelative "stinking" they were branded as the "ninth category" of anti-socialist elements. (The other eight: landlords, rich peasants, counterrevolutionaries, bad elements, rightists — since rehabilitated, traitors, spies and capitalist roaders.) Not even the dead found peace. In Shanghai, the famous biochemist Chu Hsi who died in 1962 was branded a reactionary posthumously. His body was exhumed during the Cultural Revolution and vilified over his grave.

In most places, research collapsed almost entirely, as it had in the Changchun Institute. Up to a point, the degree of disruption depended on local leadership, but going against the tide was very risky. Research institutes and laboratories were disbanded. In Shanghai alone, more than 120 of its 144 research centers that had existed before the Cultural Revolution were dissolved. Similar fate affected all professional organizations in the country, and academic journals.

Earlier this year, Shan Kuei-chang's tenure of terror came to an end. A mass meeting was held of some 5,000 people, both from the Institute itself and from other places connected with it. The 166 falsely accused researchers were publicly exonerated and reinstated. There was, however, little help for those who had succumbed to their tormentors or for the other 11 who, like the lathe operator, had commited suicide.

National Science Conference

This myopic attitude toward science started changing after the "gang of four," which included Mao's widow, Chiang Ch'ing, and a leading political troika from Shanghai, was overthrown in October, 1976. The new political leadership, headed by Hua Kuo-feng, adopted new priorities for the country; and instead of focusing on highly dubious ideological goals, it embarked on a drive to increase the country's productive forces by extraordinary margins. Their goal is to transform China into a modern and powerful socialist country by the end of this century through "four modernizations": of industry, agriculture, national defense, and — over and above all — of science and technology.

Last March, a National Science Conference was held in Peking. Its 6,000 participants constituted the greatest gathering of its kind ever witnessed in China. Among other things, the conference discussed the blueprint for the immediate future: an eight-year plan, for 1978 through 1985, to develop China's science and technology. As far as I know, its actual text has not been made public. However, its contours were discussed at the conference in some detail by Fang Yi, one of the most brilliant members of the country's new leadership, whose functions include that of the Academy of Sciences Vice President.

One of the main problems China's science and technology program faces is overcoming its low-base level. The country is generally acknowledged to be 20 years behind

Education is exploding under China's new priorities for science and technology. Since the opening of regular admissions at universities last fall over 11 million candidates have competed in entrance examinations. Academic performance rather than family background is now the leading criteria. (Photo: John Hughes, Christian Science Monitor)

The Chinese characters on the facing and following pages mean learning and technology, respectively. (Calligraphy: Wei-Yuan Hwang)

advanced world standards in most disciplines. Although in the early 1960s China started catching up in some fields, the lag of a decade or two was promptly restored during the Cultural Revolution. The first task therefore is to catch up by 1985 with the advanced world level of today in a number of important disciplines, and thus to narrow the gap again to no more than a decade. Following that, China intends to continue developing science and technology at an accelerated pace so as to be leading the pack in several fields by the end of the century.

A Revitalization of Research

Fang Yi highlighted eight target areas in which research effort will be concentrated in the coming years. The science development plan breaks them down more specifically into 108 research projects in 27 disciplines; this

breakdown, however, is not publicly available.

The target areas include agriculture, energy, materials, computer science, laser, space, high-energy physics and genetic engineering. The selection seems to reflect a two-pronged attack. On the one hand, there will be a concentration on fields with an immediate and broad impact, such as energy, materials and, above all, agriculture. In agriculture especially, it is the breadth of the research effort that is significant. Given the low level of mechanization and of labor productivity in China's countryside, and the fact that it still employs perhaps 80 per cent of the population, even modest improvements should have an immediate and considerable effect.

On the other hand, the focus will be on fields such as high-energy physics (the main item here being the construction of a 30-50 beV accelerator in the next five years, followed by a giant accelarator later on), laser, and genetic engineering. This indicates a determination not to lose contact with the cutting edge of world scientific research, and to establish a solid foundation in basic research, which during the heyday of the "gang of four" was neglected altogether. There is actually an anticipation here that specifically these three fields might lead to a new "technological revolution," even if the exact shape of future results cannot be gauged yet.

If the present level of science is rather low, the research base also leaves a lot to be desired. There seems to be a shortage of qualified people, research facilities, and information. Tsinghua University in Peking, China's M.I.T., provides examples of past destruction which border on the criminal: I was told of a very sophisticated hydraulic-engineering laboratory which was wrecked during the Cultural Revolution (instead, students were enjoined to "learn from real life"), and turned into a student-operated car factory which never really got off the ground. Tsinghua was one of the most prominent strongholds of the "gang of four"; but if facilities were destroyed there, lesser institutions probably never had them in the first place.

So one of the priorities of the science development plan is the completion of a network of research institutes to be rationally distributed throughout China's 2,000-plus counties, often dealing with problems specific to the region, and covering all branches of study. At the same time, research equipment is to be modernized. That in itself will require a whole new industry in China catering to research needs. The hydraulics laboratory at Tsinghua, needless to say, is now under reconstruction.

Similarly, the importance of information is recognized. In the next eight years, a number of information retrieval centers and data bases is to be set up, and a "preliminary national computer network of scientific and technical information" will be built.

These are badly needed, too. At the universities (it might be different in the Academy of Sciences), the situation is not very encouraging. Professor Shih, a 1947 Harvard sociology graduate, is the Head Librarian at Tsinghua. He takes loving care of his stacks (ordinarily inaccessible for browsing) which hold 2.9 million volumes, a third of them in foreign languages. On closer inspection,

the latter turn out to include arcana such as the Albanian Communist party leaders' works or the writings of Chairman Mao in Tamil, and white elephants such as a volume of papers on acoustics which since its acquisition in the early 1960s has never been checked out.

The periodicals room receives 1200 foreign journals. They include indispensable ones such as *Technology Review* as well as more obscure ones as a journal on mechanical engineering in Slovak. (I know several people here who speak Czech but no one who speaks any Slovak.) At least some foreign journals, though, are translated in their entirety into Chinese, the *Scientific American,* for one.

China certainly has plenty to offer in terms of journal exchange. Even as I am writing this, there is a news item that 11 medical journals have resumed publication after a hiatus of a decade or more. This year only, 170 academic journals have started or resumed publication, and another couple of dozen are to appear before the year is over.

Scouting Talent for Education

Another fundamental problem addressed at the science conference is the lack of trained personnel. China is going to increase the number of professional researchers to 800,000 by 1985. To this end, all resources are being mobilized. Education is exploding. Universities started regular admissions only last fall, and the interest is overwhelming: over 5 million candidates competed in entrance examinations for the 200 thousand openings available. Another 6 million sat for exams in the summer. Students are now admitted on the basis of their academic performance; family background plays a greatly diminished role in theory at least. The practice of discriminating against the youth whose grandfather was a rich peasant is over. Bright students can now enter university directly from high school, without being sent down to the countryside for a couple of years, as used to be their inescapable fate. Talent is sought for in various scientific and mathematical contests. People who do well in them have a guaranteed slot in the university of their choice. After the long–lasting chaos in the educational system, with high school students doing literally nothing else than physical labor and reciting the Works, academics are being strengthened as rapidly as possible. To this end, selected schools on all levels are under the direct supervision of provincial administrations or of the Ministry of Education.

One result of all these changes is that 30 per cent of new students at Tsinghua are children of intellectuals, excluding party officials. The reasons for this is obvious: since formal education under the "gang of four" was destroyed, it is those who had a better environment at home who come out on top now that admissions are based on merit. There are observers in the West who wonder what has happened to efforts to narrow the gap between manual and intellectual work and between the city and the countryside. They argue that the new policies corrupt the egalitarian principles of the Cultural Revolution.

They are of course right — but they refuse to recognize

Agriculture will benefit by plans heralded at the National Science Conference to form a network of research institutes throughout the Chinese countryside. Additionally, administrative and political duties of researchers have been lightened, giving them more time for their specialized fields. The researcher from the Institute of Zoology in the photo below is developing an artificial diet for lady bugs used for insect control. (Upper photo: John Hughes, Christian Science Monitor)

that in practice, these ideals have failed. The Cultural Revolution did indeed function as a kind of affirmative action program, and it was supposed to open the door to education to young workers and peasants who before had never stood a chance. This was fine — except that when the door opened, there was no education behind it. Instead of equal educational opportunities, young people got the privilege of equal ignorance. It is heartrending to meet brilliant young people in their twenties who never got the chance of concentrated study. The new generation leapfrogs over them, and their talents are now lost for good.

The masses of the toiling people are not to be forgotten, though. One motif of the science conference was opening all avenues to research. I was, however, just as impressed by a second motif, which came out most forcefully in the speech of Chairman Hua Kuo-feng: the necessity to raise the overall educational and cultural standards, in the broadest sense of the word, of the entire Chinese people. This perhaps what the Cultural Revolution wanted to achieve too. But it is now clear to the Chinese that you cannot raise the standards of the ignorant by lowering the sights of the educated.

Scientists Rise From Notoriety

In addition to training future scientists, the existing pool of qualified people is being tapped more intensively. Researchers are to do research, and not waste their time on administrative duties or on useless political meetings. At least five-sixths of their working time will now be spent on their proper work. The permanent call on specialists to be both "red," i.e. in good political standing, and expert, now has a new twist. Teng Hsiao-ping, one of the main movers of the new no-nonsense policy, has explained that in socialist China, being expert in itself amounts to being red, and that doing one's work well is good enough proof of one's political color.

The successes of contemporary Chinese science are widely popularized, and personally attributed. Thus names of leading mathematicians, geologists, agronomists, physicists, etc. are now known far beyond their immediate circle of co-workers. *China Reconstructs* recently ran a cover story about Wu Chung-hua, a leading engineering thermophysicist and Vice Director of the Institute of Mechanics. Times have changed since scientists were denigrated, criticized or ridiculed by the press. A recent play about the struggle against the "gang of four" featuring intellectuals as its protagonists would have not been possible a few years ago.

In the past, many people with university training were persecuted for their political opinions. In 1957, tens of thousands of them were branded as "rightists" and persecuted. According to world press reports, the stigma has been lifted in recent months. In line with the present policy of forging as broad a united front as possible to attain China's goals, many of them will no doubt go back to work as researchers and technicians. And the recently announced survey of scientific and technical personnel which is designed to check their numbers, qualifications, distribution and assigned work on a nation-wide basis is also obviously intended to prevent as far as possible any waste of talent.

Opening Doors to Expatriates

One may read recent official statements concerning overseas Chinese in this light as well. Under the "gang of four," overseas Chinese were often considered agents of the Taiwan regime, and returnees from abroad constituted yet another group of outcasts. Today, however, every courtesy is extended to them. There are ideological and political reasons for this, but the practical benefits, too, are undeniable. Remittances to families in China are a welcome source of foreign currency for the state. In addition, the overseas Chinese communities, perhaps some 15 million strong, represent a vast pool of scientific, technical and managerial know-how. One hears about various preferential arrangements for overseas Chinese to return, if only for a limited period of time, to share their knowledge. A week seldom passes without the press mentioning yet another distinguished Chinese-American scholar arriving here to work and to visit, received by high-ranking Chinese officials.

This naturally leads to the broader question of Sino-American cooperation and exchange. So far, it is only beginning. The Chinese are especially interested in American oil exploration and drilling technology, and four American oil companies are well on their way toward an agreement on off-shore exploitation. Generally, though, the stumbling block has been the abnormal diplomatic relationship between the two countries. In conversations with Chinese friends concerning the possibilities of cooperation, the answer always used to be, "We welcome it — but normalization of relations must come first."

In recent months, however, a subtle change is perceptible. Presidential Advisor Zbigniew Brzezinski's visit of last May was a resounding success. One result was that the Administration reversed itself and approved a controversial sale to China of a sophisticated infra-red scanning device intended for oil prospecting, but with potential military applications, too. The afterglow of Brzezinski's trip was still lingering on when Frank Press, President Carter's Science Advisor, arrived here in July, heading a powerful delegation of the scientific establishment. This fall, Secretary Schlesinger is slated to visit.

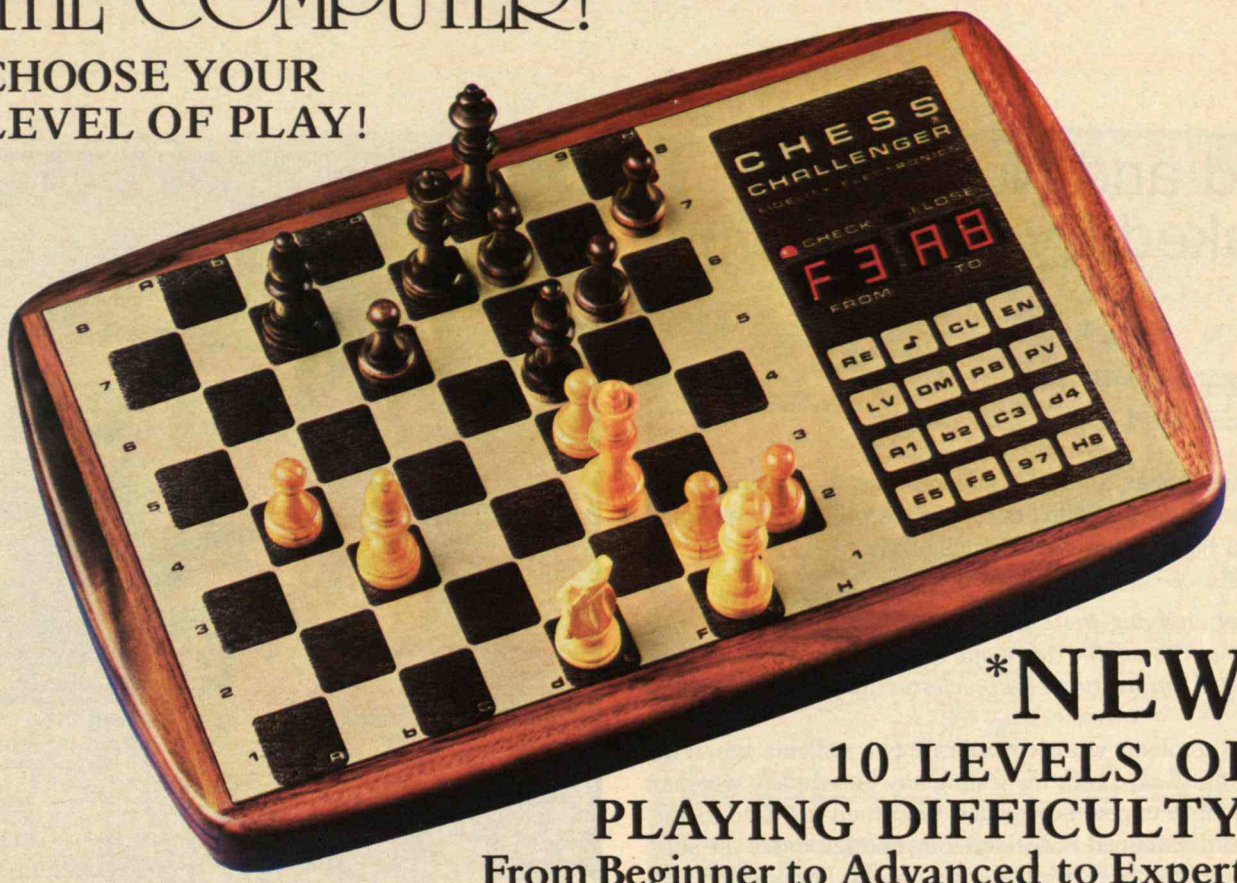
During talks here, with the leadership of the Chinese Academy of Sciences and the Academy of Social Sciences, including Vice Premier Fang Yi, Dr. Press' delegation outlined various areas in which cooperation would be possible and fruitful. The response was far from discouraging, and discussions are supposed to continue, leading hopefully to concrete results in areas such as student exchanges, technology transfer, cooperation in agriculture, etc. Nobody will say it in so many words, but during these past months, the general mood seems to have shifted from one of "cooperation after normalization" to the far more practical "through cooperation toward normalization."

Karel Kovanda received a Ph.D. in political science from M.I.T in 1975. He is currently working as a foreign expert for Radio Peking.

A NEW* CHALLENGE!

PIT YOUR CHESS SKILLS AGAINST THE COMPUTER!

CHOOSE YOUR LEVEL OF PLAY!



*NEW!

10 LEVELS OF PLAYING DIFFICULTY!

From Beginner to Advanced to Expert!

You choose your opponent's level of playing difficulty – from novice to expert. You choose black or white pieces. You enter your initial move. In seconds, the computer analyzes all possible countermoves and makes its best move. Day or night, Chess Challenger "10" is ready to give you a classic battle. The computer will sharpen your game and is the perfect teacher with features like:

- A library of classic book openings
- Random responses – no two games alike
- Does not permit you to make illegal moves
- Solves mate-in-two problems
- Position verification by computer memory call
- Analyzes as many as 3,024,000 board positions
- Double move entry for castling and handicapping
- Hand carved, magnetized French Chess Pieces

Chess Challenger "10" provides the flexibility and variety for a lifetime of classic chess battles. Accept the challenge and order yours today!

SPECIFICATIONS:

CHESS CHALLENGER® "10" is housed in a solid walnut case, 13 x 8 x 1-1/4" with felt foot pads. Simulated leather and gold foil playing area and keyboard. U.L. approved 110 volt A.C. 100% solid state for years of trouble-free use. No batteries used.

ACCEPT THE CHALLENGE! ORDER YOURS TODAY!

_____Yes, please send____Chess Challenger(s) "10" $275.00 each plus $8.00 each for shipping and insurance. IF I AM NOT SATISFIED, I may return within 15 days for a complete refund.

_____My check is enclosed (N.Y. residents add 5% sales tax).

_____Charge my credit card no._____

_____Visa____Master Charge____Amer. Express Exp. Date_____

Signature_____

Name_____

Street_____

City_____State_____Zip_____

Send to: THE PLEASANTVILLE PLAN, Dept. MIT6
62 Eastview Ave., Pleasantville, N.Y.10570

Order Toll Free 800-243-5676 – 24 Hours per Day – 7 Days per Week
(Connecticut Residents Call 1-800-882-5577)

Old and New World Naked-Eye Astronomy

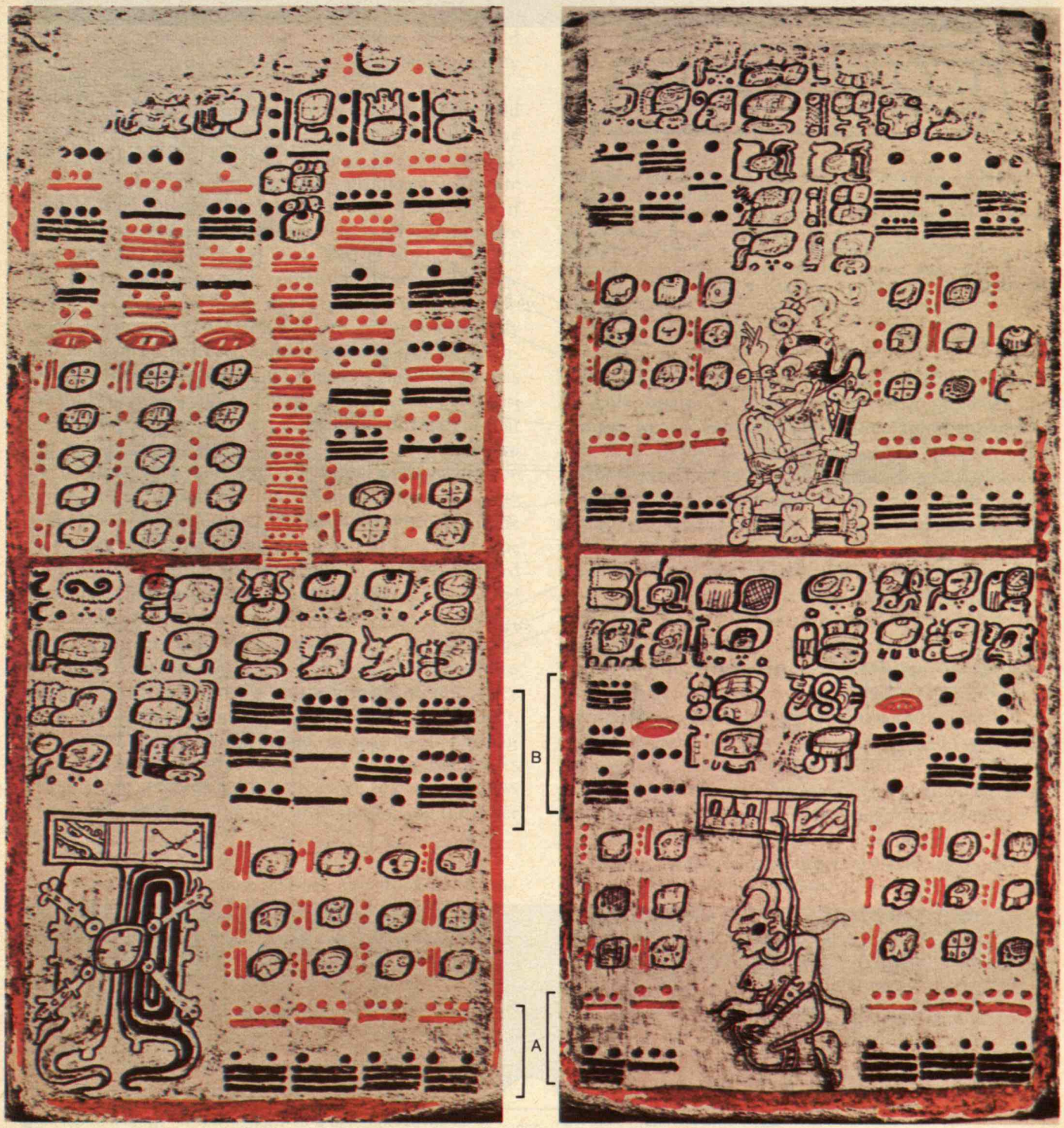
Anthony F. Aveni

The similarities are more striking than the differences, but then why shouldn't careful observation of universal cycles have led to like conclusions?

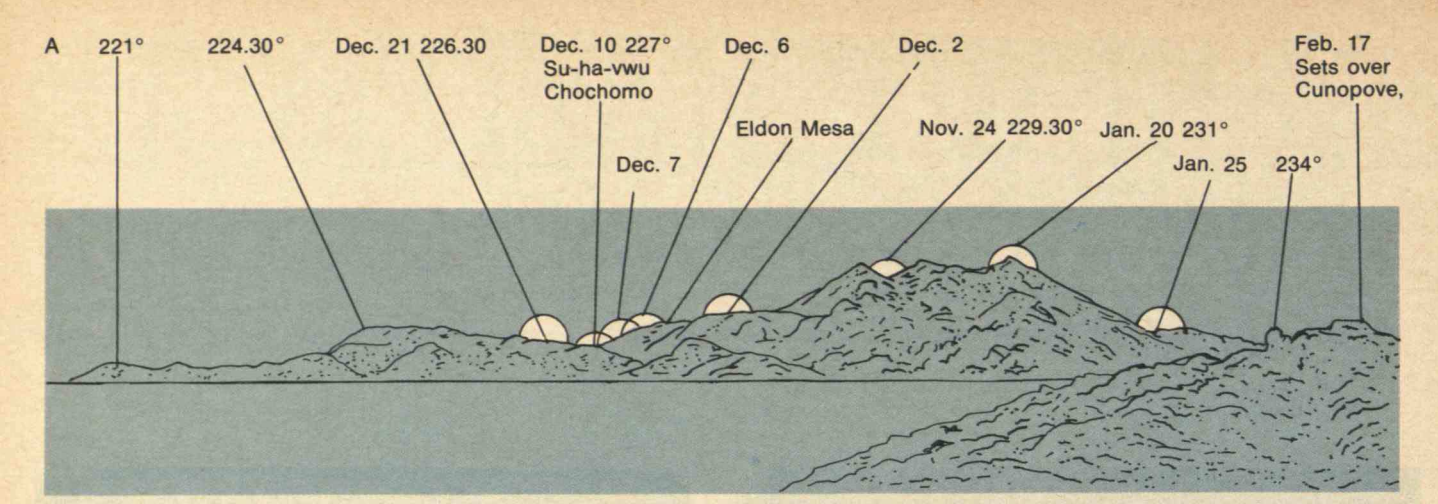
". . . in studying the convoluted orbits of the stars, my feet do not touch the earth, and seated at the table of Zeus himself, I am nurtured with celestial ambrosia."

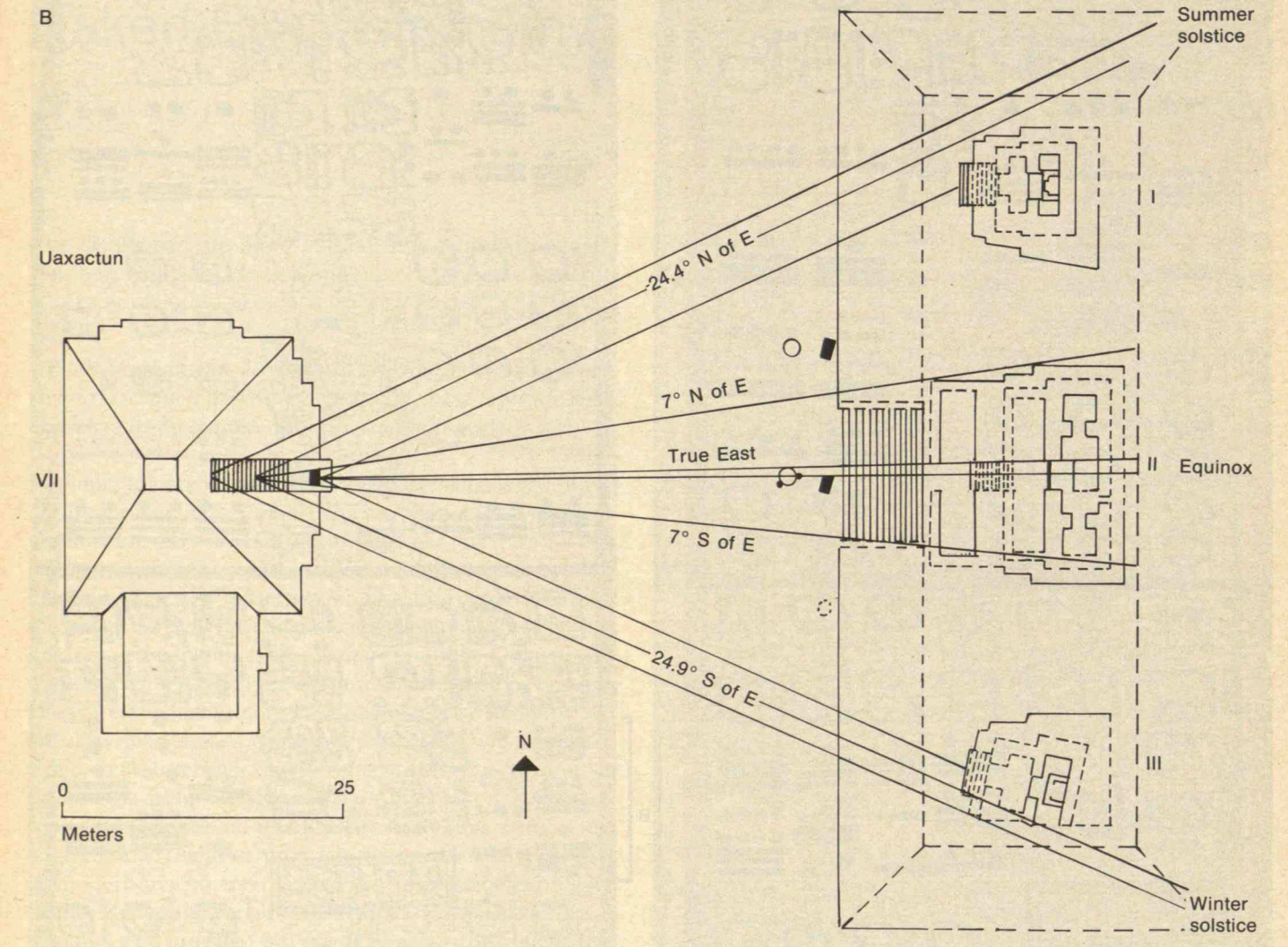
Though Ptolemy wrote that phrase two millenia ago, it no doubt aptly expresses the feeling any ancient sky watcher would have experienced when he turned his gaze to the stars and remained transfixed long enough to see the sublime precision of celestial motion unfold. For modern folk the majesty of the firmament is unveiled only through the mastery of a complex instrumentation — one of the products of a technological revolution unsurpassed in human history. Dependent upon our modern sense-extenders, yet awed by the remains of the ancient world, we ask, how could our forebears have constructed the pyramids, erected the statues on Easter Island, or carved the Olmec heads without technological assistance? How could they have attained their scientific achievements without the aid of modern machinery? Some of us feel compelled to attribute their mighty endeavors to outsiders, ancient astronauts who long ago traversed the galaxy bearing us the

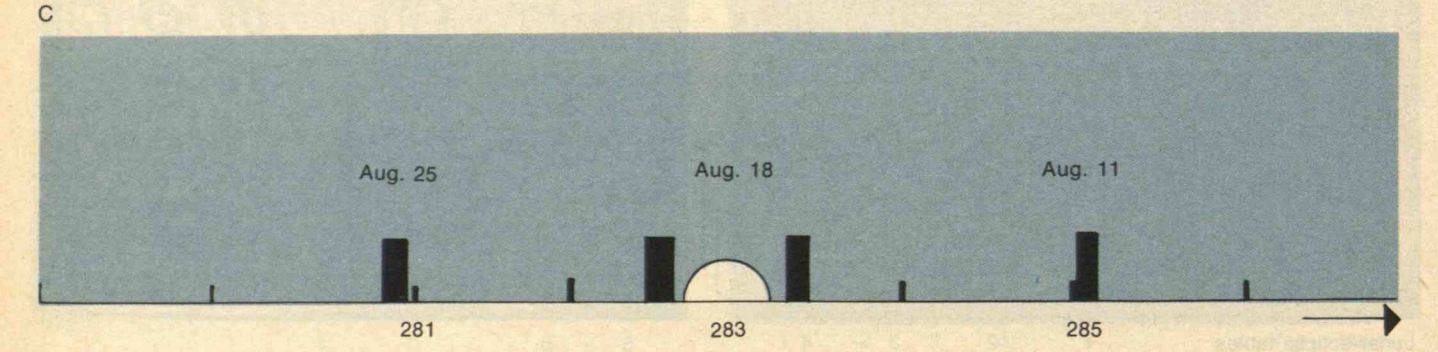
New World Cosmologies. For Ptolemy (A.D. 1501), the heavens consisted of bodies orbiting the earth in divine circular paths. Though his views were modified during the Renaissance (the sun was placed at the center), the orbital concept persists in modern astronomy. The Maya, on the other hand, took the universe to consist of interlocking time cycles, two of which are captured by the maze of numbers (represented by dots and bars) in the lunar-eclipse and Venus tables of the Dresden Codex (A.D. 1200). Details are given in the text. (These tables were originally published in J. Eric S. Thompson's "A Commentary on the Dresden Codex," *Memoirs of the American Philosophical Society,* Vol. 93, 1972.)



Lunar-eclipse tables 1 2 3 4 5 6


A
221°
224.30°
Dec. 21 226.30
Dec. 10 227°
Su-ha-vwu
Chochomo
Dec. 7
Dec. 6
Eldon Mesa
Dec. 2
Nov. 24 229.30°
Jan. 20 231°
Jan. 25
234°
Feb. 17
Sets over
Cunopove,

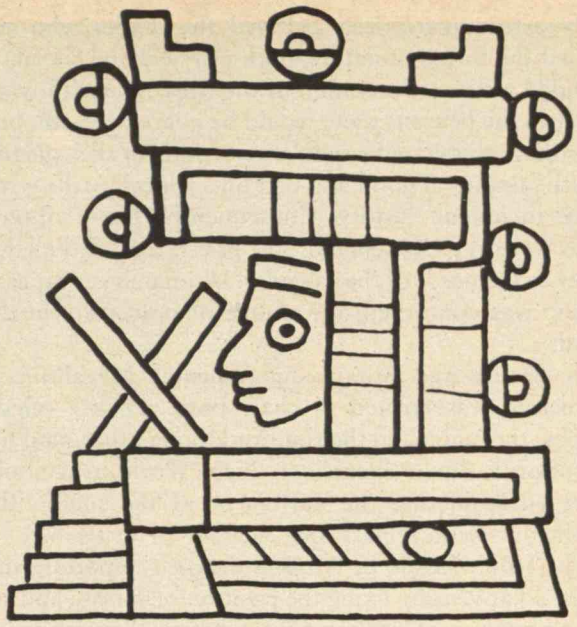

B
Summer
solstice
I
Uaxactun
24.4° N of E
7° N of E
True East
II
Equinox
VII
7° S of E
24.9° S of E
N
III
0
25
Meters
Winter
solstice


C
Aug. 25
Aug. 18
Aug. 11
281
283
285

gift of a great science and technology which has since vanished from the pages of history.

But the loss may be in ourselves. Ancient records tell us that our predecessors scaled great astronomical heights. Because the heavens were a part of their lives, they labored attentively to follow their gods and goddesses, who were symbolized by the sun and the moon, the planets and stars. They enjoyed an intimate contact with nature — a contact which technology forbids us by creating the artifical environment in which we play out our lives. Indeed, ancient astronomers were nurtured with celestial ambrosia only because they pulled up to the table and helped themselves. In the Old World of the Mediterranean, they created most of the astronomy with which we as historians are familiar. On the American continent, other races, entirely separate from those of the Old World, also created a sophisticated system, an astronomy of equal brilliance.

It is instructive to contrast certain aspects of the Old and New World systems in order to show how naked-eye observations of the heavens, at times interpreted similarly, at other times differently, produced exquisite models of the universe for the inhabitants of both sides of the Atlantic. These models, often laced with impressive geometry and numerology, were used to predict the future course of events with surprising accuracy. Because space does not allow us the opportunity to review the detailed astronomical progress of both cultures, especially in a field which has been called the world's oldest scientific profession, we shall utilize selected examples, such as the study of lunar eclipses and the cyclic motion of Venus, to demonstrate the quantity of detailed information that can be extracted from simple observations. We shall also try to show how and why the mental frameworks in which these astronomies thrived influenced the way people viewed the cosmos. The lesson of history will be that science and the course of human affairs shape one another. Why did all ancient civilizations look skyward early in their development? Surely chronology made the earliest demands upon astronomers of antiquity. Ancient hunter-gatherers kept close watch on the changing appearance of the sun and moon. For them, these luminous disks were created expressly for the keeping of time. They were the primal source of continuing and variable light, of the tides, of body rhythms and the seasons. In particular, two basic cycles, one of them comprising the phases of the moon, represented by successive first appearances of the thin crescent in the west after sunset, and the other



The use of crossed sticks to fix the positions of astronomical objects at the horizon. This figure shows an astronomer with crossed sticks perched in the doorway of a temple. Stars studding the outside of the structure give it a special astronomical significance. The image is taken from a Mesoamerican picture document that survived the Spanish conquest. Mesoamerican architects often oriented temples preferentially so that they would align with specific astronomical events at the horizon.

the annual solar cycle, most easily discerned by following the daily progress of the sun on the horizon at dawn and at dusk, were found to be represented approximately by 29½ and 365¼ day periods.

Our minds constantly seek to make order out of chaos, so it is not surprising that the first astronomers, striving to capture the pulse beat of the universe, felt the necessity to fit the solar and lunar rhythms together. But an integral number of lunar-phase cycles will not divide exactly into the tropical year. A round of 12 moons falls 11 days short and 13 moons falls 19 days long.* Accordingly, we find many early chronologers alternating between years of 12 and 13 months. After a period of 19 years — the so-called cycle of Meton, devised by that Athenian astronomer in the fourth century B.C. — the two were found to fit together perfectly. In a sense, astronomers had fashioned a large gear in their universal time machine which meshed perfectly with two smaller gears. The attempt to group together shorter periods to make longer ones seems to be a common characteristic of early astronomers.

But why did the celestial observers strive for precision? Pristine perfection lay beyond the elementary needs of meteorological or agricultural prediction with which early sky watching was concerned. The answer lies in the human spiritual realm. Religious ceremonies always attended the completion of one of nature's basic cycles, and

Three New World sun-watching schemes, all of them involving the sun at the horizon. Figure **A** shows a calendar in the landscape. The Hopi-Navajo marked important days in the year by memorizing the positions of prominent notches or peaks on the local horizon where the sun stood on important dates. Figure **B** depicts Uaxactun Group E, a Maya Solar Observatory. An observer situated on the large pyramid marked the sunrise over the tops of three eastern temples precisely placed at the solstices and the equinoxes. Figure **C** suggests how the horizon becomes an agricultural timetable. The Inca of ancient Peru built cylindrical towers along the horizon of Cuzco, their capital. When the setting sun arrived at a particular tower, the planting time for a certain elevation was said to be correct. Arrival of the sun at another tower signified that crops should be sown at a different elevation.

*This seems not to have bothered the Romans, who handed down our modern calendar of 12 fixed months (a contraction of moon-ths) per year — a time scheme which bears no sensible relation to the events it purports to represent. Already the civilized world was beginning to detach itself from the environment.

early astronomer-priests believed the deities who controlled the forces of nature, both physical and social, demanded a strict observation of the rites. When all was in order in the heavens there would be peace on earth, but a disorder necessitated careful corrections in the calendar, lest the timing of good and bad omens occupy the wrong place in human history. Consequently, better observations were in great demand. The priests attended meticulously to the needs of the calendar. Ultimately, as far as the public was concerned, the source of power lay in their hands.

In Bronze-Age Britain, monumental Megalithic architecture was created to chart both primary celestial deities: the moon and the sun. And though they paid little attention to lunar excursions, New World astronomers were encapsulating the movement of the sun in their earthworks with remarkable accuracy (*see page 62*).

The Hopi-Navajo of Arizona denoted important days in the solar year by fixing the position of sunrise and sunset on prominent peaks and notches in their landscape. The ancient Maya of Yucatan, probably the cleverest astronomers in the Americas, incorporated the sun's movement into their architecture by way of an ingenious "solar observatory" which they erected about the beginning of the Christian era. Standing atop pyramid E-VII at Uaxactun, the astronomer-priest could see the sun rise on different days of the year over a cluster of three temples located opposite an open plaza to the east of his vantage point. Embedded in dense rainforest, these buildings were carefully erected on artificially elevated mounds so that the top of the northernmost structure precisely marked the position of sunrise on the longest day of the year, June 21, when the sun reaches its most northerly sunrise position. Conversely, the southernmost building fixed the sunrise on the shortest day of the year, December 21. These standstill positions, called solstices by the Greeks, who also watched them, must have been important time markers for the ancient Maya. The sun was watched with great care as well on the equinoxes (March 21 and September 20), when the central building precisely marked its rising position. On these two dates, the sun rises exactly in the east and sets due west. Daylight and darkness are of exactly equal duration.

Observing the sun when it is high in the sky. Ancient astronomers of the New World attached great importance to the days when it passed directly overhead at noon. In one case they noted this time by receiving the light of the sun through a vertical tube incorporated into one of their monuments: Structure P at Monte Alban.

What devices were used to establish these sun alignments? We think ancient American astronomers employed a set of crossed sticks to register the position of the sun precisely, so that the architecture could be aligned accordingly. Codices (that is to say, picture documents) surviving from before the time of the Spanish conquest reveal astronomers posing in the doorways of buildings, their instruments in hand, aligning their gaze toward distant objects along the local horizon (*see the figures on the cover of this issue and on p. 63*). A crossed stick mounted atop a pole (or perhaps a natural marker in the landscape) would serve as a backsight; and an ancient astronomer could then plant a stick as a foresight and fix a solar alignment by observing the sunset on a given day precisely through both notches. Permanent markers could later be used to fix the positions of the two locations, and on successive days, the astronomer would adjust one of the sticks and mark new alignments to follow the changing positions of the sun at the horizon throughout the year. The return of the sun from the same direction to its original position would indicate that a solar-year cycle had been concluded. The same principle would apply to the moon and the planets, which describe more complicated horizon periodicities.

How accurately can one determine celestial position by such an observation technique? Suppose a distant foresight is fixed and the backsight is to be set up 500 meters from it. If an angular error of one quarter of a degree (about half the angular diameter of the sun) is allowed, then the backsight can be laterally misaligned by as much as two meters without transcending the margin of error. (One easy way to estimate such errors: for a pair of sighting sticks at one kilometer separation requiring an accuracy of one solar diameter, the lateral displacement is eight meters.) Since the daily shift of the sunrise and sunset positions along the horizon is more than one-quarter of a degree (except near the solstices), we learn that the simplest naked-eye observations could easily be used to transform the natural or architectural environment to graphically tally a day-by-day account of the motion of the sun throughout the year.

In Cuzco, Peru, the ancient Inca monitored the sun's

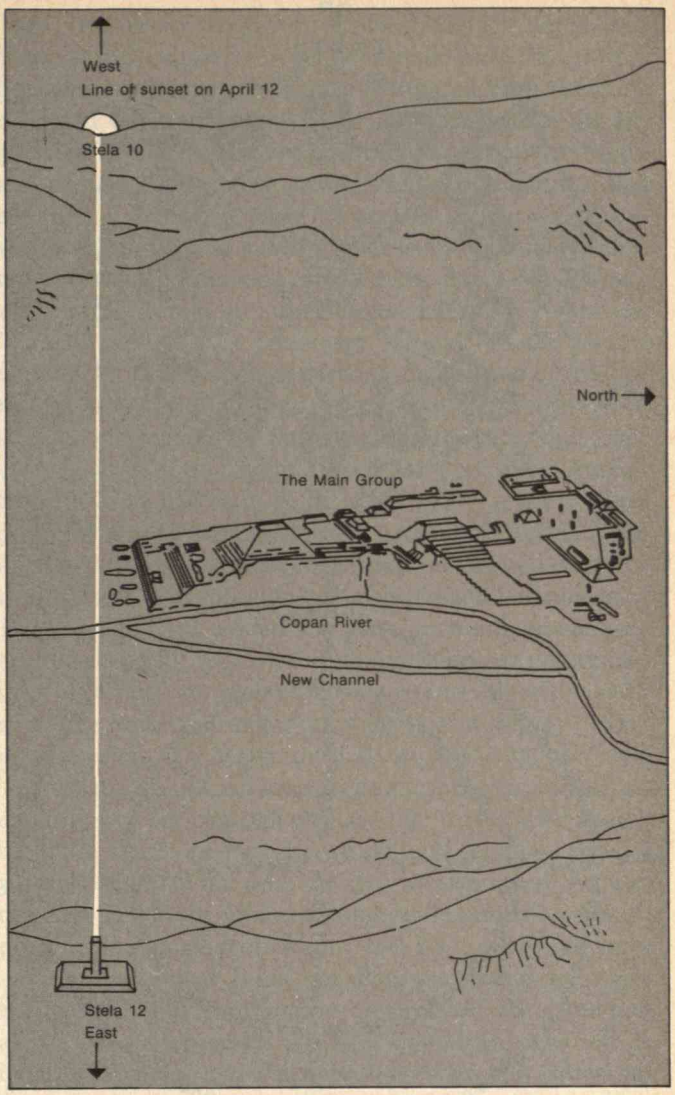
movement during the most crucial times of the year by erecting a set of four cylindrical towers, or *mojones,* on the highest hill to the west of their capital (*shown in part C of the figure on page 62*). The astronomer performed his duty atop the Ushnu, a pyramid located in the middle of this ceremonial center. For there he viewed the sunset on its daily progress toward north during August, thus forecasting the arrival of spring in the southern hemisphere. Spanish chroniclers living in Cuzco shortly after the Hispanic invasion tell us that when the sun touched the southernmost tower, it was time to begin to plant maize in the highest elevations surrounding the valley of Cuzco.

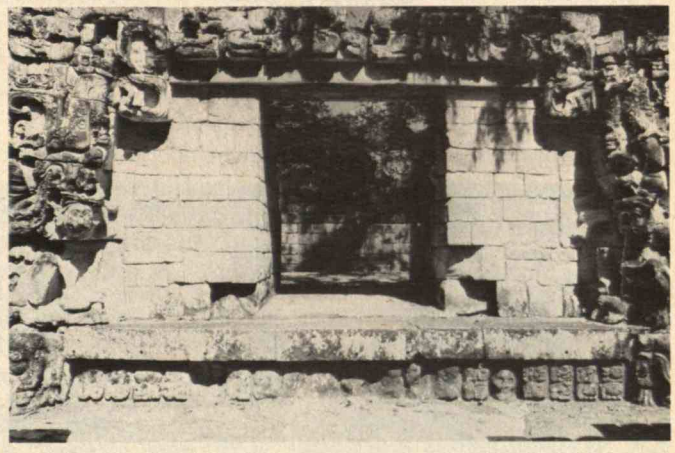
A week later, when the sun's image was framed by the pair of towers in the middle of the array, farmers within the valley of Cuzco started their planting. When the sun returned from the south the sun towers served a similar function, this time to set the intervals within which to harvest the crops. The Inca had converted their landscape into an accurate agricultural timetable.

The Indian civilizations of the Americas flourished in the tropics. Here the sky takes on a different aspect from that in the more temperate climates where the Classical civilizations developed. Therefore, we might anticipate that the astronomies of these diverse cultures would exhibit some differences. For example, Inca, Maya, and Mexican astronomers noted the dates of passage of the sun across the zenith, a phenomenon which has no analog in the temperate zones, and in much of Central America these dates served a meteorological function, foretelling the start of the rainy season. One seventeenth-century Yucatecan writer, Juan Pio Perez, attaches a further significance to the zenith days in the calendar which his native ancestors had used 400 years earlier:

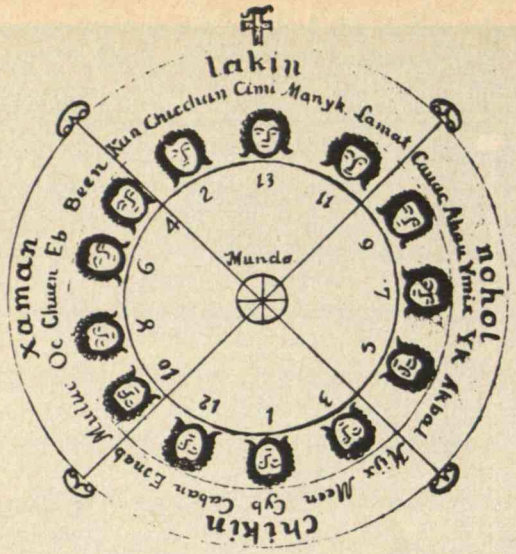
"Our progenitors [he reports] sought to make the New Year begin from the precise day when the sun returns to the zenith of this peninsula on his way to the southern regions, but being destitute of instruments for their astronomical observations and guided only by the naked eye, erred only 48 hours in advance. That small difference proves that they endeavored to determine with the utmost attainable accuracy the day on which the luminary passed the most culminating point of our sphere and were not ignorant of the use of the gnomon in the most tempestuous days of the rainy season." As best we can judge from old maps of Cuzco and the chronicler's words, the key date must have occurred about August 18. Unfortunately, nothing remains of the towers today. The Spanish conquerors dismantled them stone by stone in the sixteenth century for use in the construction of aqueducts in their new city.

In ancient Greece astronomers marked the progress of the sun by following the shadow of a vertical stick or gnomon on a calibrated plate. But we cannot say for sure whether shadow-casting techniques with a gnomon were important in America. Evidence from New World archeoastronomical studies suggests it is more likely that the image of the sun was received through a vertical hole incorporated into a special sun temple. Such a device

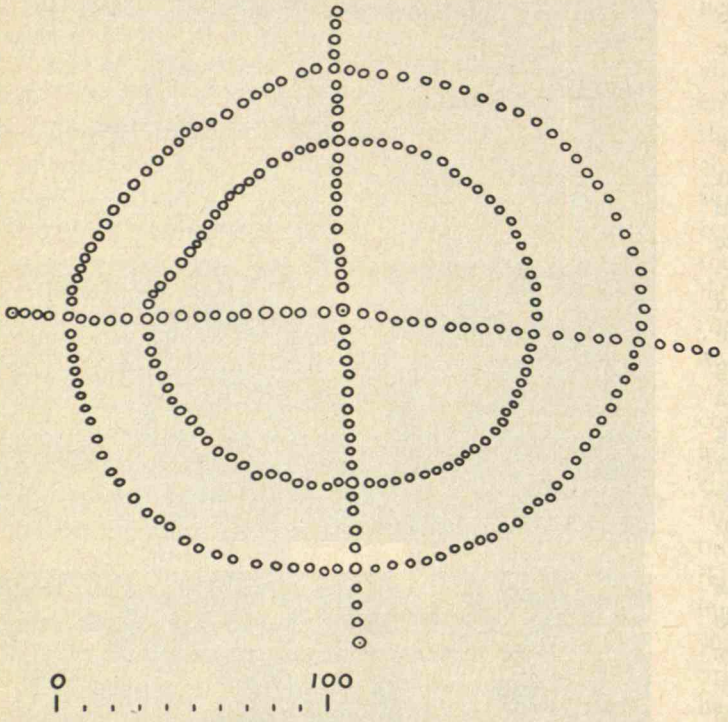


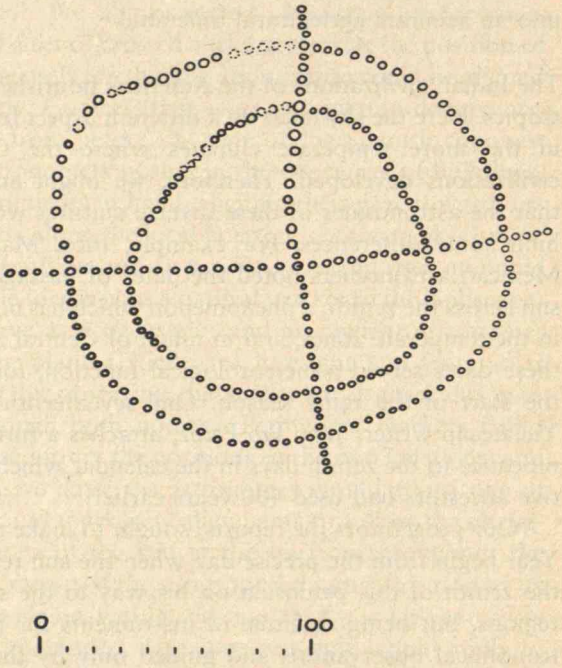


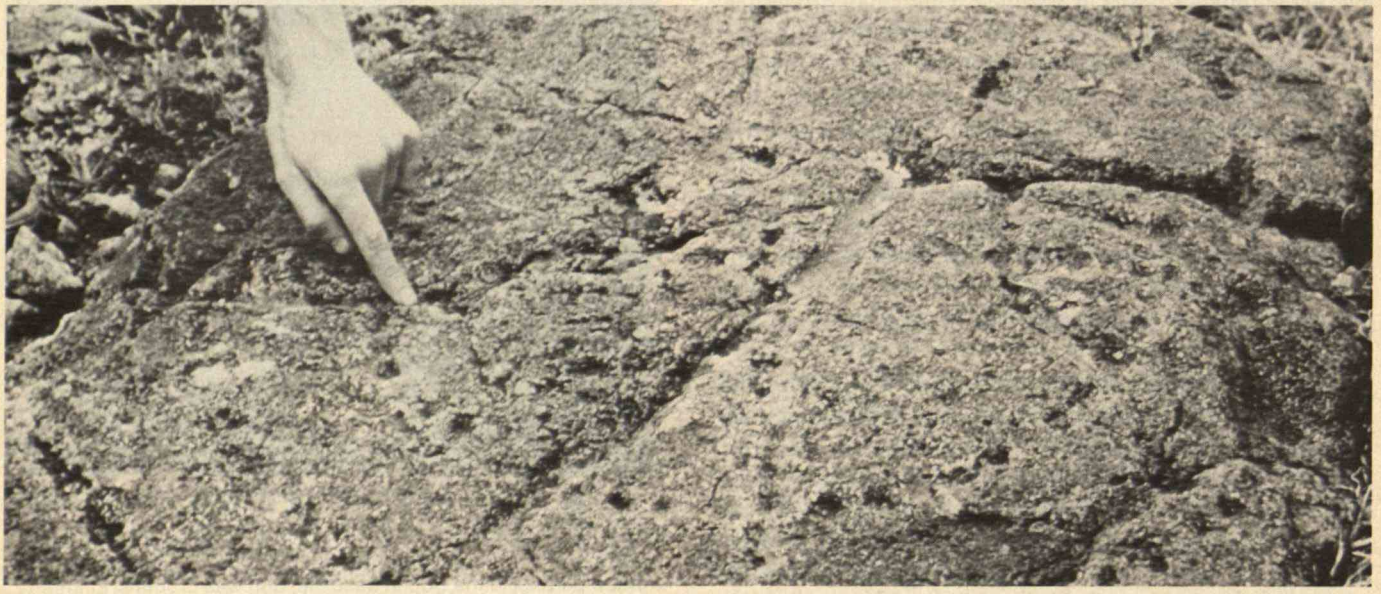
The astronomical baseline at Copan, Honduras. It stretches seven kilometers from Stela 12, a monument adorned with hieroglyphs on a slope overlooking Copan, to a hill to the west of the ruins. On a date conveniently arranged by the gods to fall within 20 days of both solstice and zenithal passage, the agricultural season officially commenced. The Copan buildings in the valley below were also oriented in the sacred direction. Thus the religious center of the real world could function in total harmony with the spiritual world of the heavens. A photograph shows the Temple of the god Venus, also located at Copan. It bears that name because of sculptures depicting Venus symbols that are found in the doorway. A product of the Classic Maya age (about A.D. 700), it possesses a window parallel to the Copan baseline, and was probably intended to fix the same alignment.



Pecked-cross petroglyphs, which abound in Mexico. The symbol is carved in the floors of buildings and on rock outcrops, and was used to fix astronomical orientations. But an analysis of the arrangement of the dots which make up its design also suggests that it functioned as a calendar. An insert therefore shows the calendar from the sacred book of Chilam Balam of Kaua. Like the petroglyphs that it resembles, the quartered circle embodies both spatial and temporal aspects. The four cardinal directions and the intercardinal points are attached to a fixed earth. Around the horizon which borders the diagram flow cycles of 20 named and 13 numbered days (compare with our system of weekdays with names and days of the month with numbers). The numbered days are here represented by heads.







permitted a shaft of solar light to pass into a structure. Consider Monument P at Monte Alban, in modern-day Oaxaca, about a day's drive from Mexico City (*see page 64*). Though it was built more than 2,000 years ago, the image of the sun still passes through such a tube onto a small altar on the two days of the year, May 8 and August 5, when the sun casts no shadow at noon. This zenithal sight tube is fashioned so as to receive an image of the sky 1½° wide. Thus it will admit at least a portion of the sun a few days before or after a true zenith passage. However, by experiment the sun's disk can be precisely centered in the field of view only on the day of zenith passage.

Across the plaza, another astronomer may have stood in the pre-dawn twilight on the day of zenith passage, crossed sticks in hand, in a small room atop Structure J, which was deliberately skewed from all other buildings at the Zapotec hilltop site. The line of his gaze, directed by the orientation of the door jamb, would pass directly over the access chamber to the solar observatory, reaching the eastern horizon precisely at the place where the bright star Capella rose to announce the crossing of the sun in the zenith; for, at the latitude and building time of Monte Alban, Capella made its first annual appearance in the pre-dawn eastern sky (its first heliacal rising) on the same day the sun later underwent its first zenith passage.

The alignments at Monte Alban and Uaxactun reveal that the ancient Mesoamericans had a penchant for utilizing architecture and the landscape to scale the progress of celestial luminaries; but they developed even more sophisticated schemes than those already mentioned. At Copan, one of the most enchanting Maya ruins, astronomer-priests carefully marked the sunset for the day the native farmers were to start their agricultural calendar: they erected a pair of curved stelae at opposite ends of seven-kilometer baseline (*see page 65*). The people of Copan, like those of Cuzco, believed that when this annual solar event occurred, the gods signalled permission to the people to cut and burn the bush extant from last year's harvest. Only then would all be in order for the planting ahead. Their solar observations also foretold that nourishment from the heaven-sent tropical rains would soon follow. But there was more than a simple agricultural-astronomical arrangement here, for the sightline also served to segment the calendar into divisions which incorporated both the tropical year and a unique ritual cycle of 260 days. This latter period, found only in Mesoamerican calendrics, was composed of a sequence of 13 numbers matched successively with 20 day-names — much like our system which pairs seven day-names with 30 (or 31) numbered days of the month. The numbers and day-names appear in the calendar shown on the facing page. Now either by coincidence or by design, Copan lies at precisely the latitude where the sun will spend 260 days south of the celestial zenith; on the remaining 105 days of the year, it passes north of the zenith at noon. Some investigators have suggested that the location of Copan was deliberately fixed so that the ancient ceremonial center would be in harmony with the religious calendar.

The Teotihuacan empire of Central Mexico dominated New World cultures for nearly a millenium. Its power, breadth, and longevity may be compared with the conquests of Caesar and Alexander. At Teotihuacan the expression of a knowledge of positional astronomy through the precise geometrical arrangement of buildings and ceremonial centers reached its greatest height. Indeed, a special multipurpose symbol possessing both spatial and temporal aspects remains carved in the floors of buildings wherever Teotihuacan influence was felt in Mesoamerica. We will explain it in a moment. The key to the precise rectangular grid system underlying the scheme of the city resides in a pair of curious petroglyphs (figures carved in stone), one located in the center of the city, the other visible on the slope of a hill three kilometers to the west of the ruins. The line between them lies within seven minutes of arc of a perpendicular to the north-south Teotihuacan axis. Accordingly, archaeologists who excavated the ruins during the 1960s speculated that the original architects of Teotihuacan had a definite plan in mind when they erected their city. Once the rectangular grid structure had been sketched out, all later constructions adhered rigidly to it. The peculiar orientation of the axis of the city (15½° to the east of astronomical north) suggests the Teotihuacanos utilized an astronomical theme. In fact, an extension of the petroglyph base line to the west marks the place where the Pleiades would have set along the elevated horizon at the time the city was designed. As was the case at Monte Alban, a solar-stellar functional relationship is also evident. About 150 B.C., when the ceremonial center was built, the Pleiades underwent their heliacal rising at Teotihuacan on precisely the same day as the first solar zenith passage. Ethnohistorians tell us that the Pleiades are well represented in Mesoamerican star lore. For the Aztecs, in fact, they were the most important celestial grouping. Priests regularly traveled to the Hill of the Star in ancient Mexico City specifically to watch that prominent little cluster transit the zenith.

The form of the special symbol mentioned above turns out to be every bit as interesting as the Teotihuacan orientation problem. The design occurs in one form or another thirty times as petroglyphs at ruins ranging from the mountainous borderland of the U.S. and Mexico to the rainforest of Guatemala. It usually consists of a pair of double concentric circles, quartered by a set of rectangular axes (*see the examples on the facing page*). The design is formed by a series of circular depressions made with a percussive device. Sixteen examples of the symbol occur in the immediate environment of the great pyramids of Teotihuacan. They are usually found on the surfaces of large rock outcrops at sites where the observer is offered a commanding view of the landscape. One particularly impressive carving (*see the photograph at the left*) is pecked onto a flat rock on a hillside at Tepeapulco, a colony of the empire located 33 kilometers to the northeast. The axis points directly toward Cerro Gordo, a large mountain blocking the view of Teotihuacan. Perched atop Cerro Gordo, we find another such petroglyph overlooking both Tepeapulco and Teotihuacan itself.

Since any such symbol is usually in plain view of another, it has been suggested that these designs were part of a network used to communicate information between Teotihuacan and its colonies, perhaps by signalling with polished stone or by lighting fires. To other investigators, they are merely sun symbols. But careful inspection reveals that this curious form of rock art also harbors specific astronomical and calendrical information. In a number of cases, the rectangular axes align with the summer solstice sunrise position on the horizon. Two such markers are situated next to each other on Cerro El Chapin, a plateau which straddles the Tropic of Cancer (latitude 23° 27′ N.). The tropic is the only place in the northern hemisphere where the zenith-passage date would correspond identically to the summer solstice. The deliberate location of the symbols at the Tropic therefore probably represented a serious attempt by Teotihuacan astronomers to seek the place where the sun turned around on its annual journey a thousand kilometers north of their city. Moreover, this pair of petroglyphs was employed to wed the solar cycle to the landscape and some of the nearby architecture by an ingenious scheme involving a double astronomical alignment. Standing on either petroglyph, an observer sees the sun rise at the June solstice over Cerro Picacho, the most prominent peak on the horizon. And at the ruins of Alta Vista, seven kilometers to the north, the observer situated in the principal structure, now called the Sun Temple, can view the sunrise at the equinoxes over the same peak. For good measure, the Sun Temple was built with its corners directed toward the cardinal points of the horizon. The drawing on the facing page illustrates this complex arrangement.

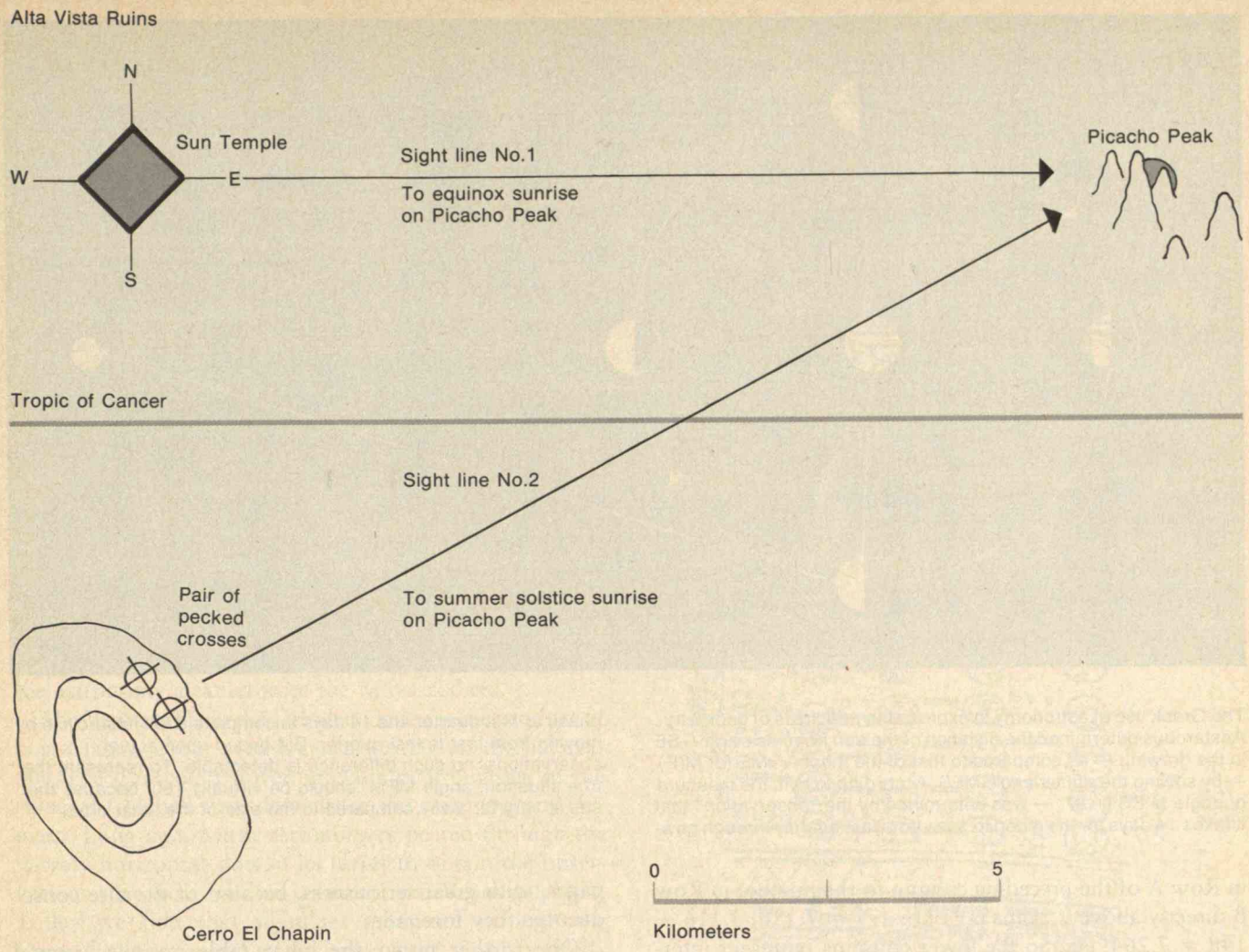
Now the Cerro El Chapin petroglyphs contain numerical as well as directional information, and again the key Mesoamerican calendric number 260 is involved; for both of the El Chapin symbols are composed of 260 depressions — 72 on the axes, 84 on the inner circle, and 104 on the outer. Moreover, over three-quarters of the petroglyphs discovered to date display the following arrangement of points on each of their axes: 10 between the center and the inner circle, 4 between each circle, and 4 beyond the outermost circle. Thus if we move outward from the central point and include in our count the points at the intersection of an axis with either of the circles, we find 10 + 1 + 4 + 1 + 4, or 20 points, a number we might well anticipate if these petroglyphs were used as mathematical devices, as it represents the number of named days in a month.

The full meaning of the symbolism of the quartered circle still eludes us. Nevertheless, it seems likely that the creators of these designs had a multiple function in mind: that these symbols served as architects' bench-marks, as astronomical orientation devices, and as calendric counters, all at once. After all, studies of calendars surviving in the pre-Hispanic codices suggest that pre-Columbian astronomers sought to embody both spatial and temporal aspects in their cosmology. For example, the count of days and year-bearers (the names of the days of successive new years) are assigned directions in space on many of the calendars, including the one on page 66. Moreover, the unification of space and time may be seen as well in the construction of the Copan baseline. If such a conceptualization of the real world looks strange to modern eyes, consider the unification of space and time sought by the twentieth-century physicists who advanced the theory of general relativity. Einstein's approach, though more sophisticated and abstract, evokes the same theme and strives for the same goal.

In our own Western heritage, the Parthenon turns out to have an astronomical orientation: it was aligned to face the sunrise on the birthday of Athena, the goddess to whom it was dedicated. And even as late as the seventeenth century in England, cathedrals were oriented celestially. We read in an early work of that era: "One end of every Church doth point to such Place, where the Sun did rise at the time the Foundation thereof was laid, which is the Reason why all Churches do not directly point to the East; for if the Foundation was laid in June, it pointed to the Northeast, where the Sun rises at that time of the year; if it was laid in the Spring or Autumn, it was directed full East; if in Winter, Southeast. . ." Thus a careful observer could tell at what time of year the foundation was laid by which direction the building was pointed.

But these may be unusual examples. Generally, in the Old World, astronomical knowledge was recorded and transmitted through the written word. The Babylonians produced cuneiform tablets, and the ancient Greeks' love of the metric is revealed throught the medium of pen and paper. In fact, in the Greek philosophical tradition, geometry and geometrical logic grew to be ends in themselves, and naked-eye astronomy provided good subject matter on which to practice this quantitative art. Often the facts of observation became distorted to emphasize a geometrical proof. Consider, for example, the logic Aristarchus employs to determine the relative distances of the sun and moon from the earth, as diagrammed on page 70. To arrive at his result, he relies upon a single fact of observation: that the interval between first and last quarter moon exceeds that between last and first. But his casual statement that he observed a genuine difference between these intervals may be taken to be a deliberate falsification of the facts for the sake of saving the geometry. Even with modern telescopes, no such difference between the intervals is discernible. If one were to draw Aristarchus's diagram to proper scale, the earth-sun distance would be required to measure approximately 400 times the earth-moon distance, thus completely changing the scale of the geometry and making it quite impossible to commit the beautiful proof to paper. There can be no doubt that for Aristarchus empirical facts of nature were subordinate to geometrical logic.

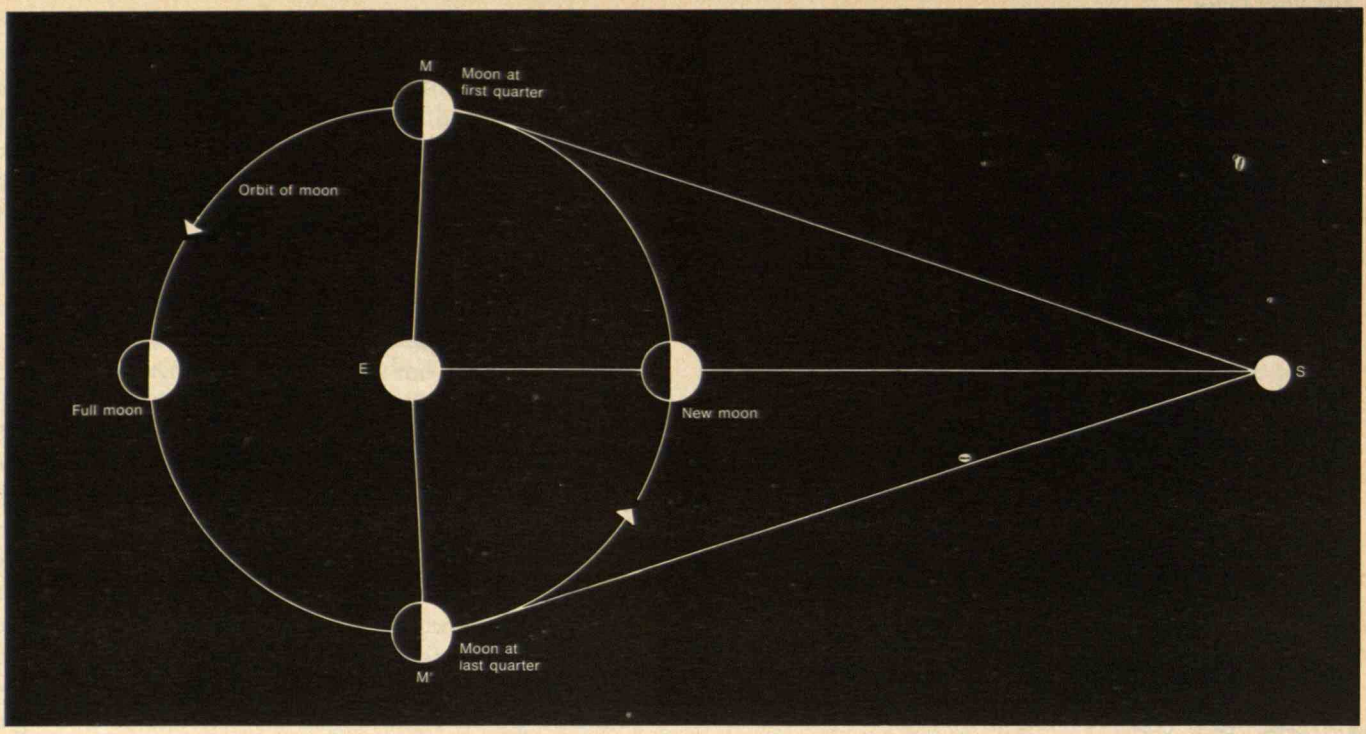
To appreciate the peculiar treatment the Greeks accorded the heavens we must understand that their cultural background profoundly affected the way they practiced this discipline. In Greece, astronomy was not a priestly profession but instead a lay discipline which developed in a democratic society of free-thinking individuals. Unlike the Babylonians (or the Maya), the Greeks were not haunted by horoscopic problems. Thus they



The Alta Vista/El Chapin double solar alignment. From a pair of petroglyphs on the plateau of Cerro El Chapin, an astronomer-priest could watch the June solstice sun rise over Cerro Picacho, the most prominent peak on the horizon. The same phenomenon, shifted to the March and September equinoxes, is visible from the Sun Temple at the Alta Vista ruins 10 kilometers to the north.

were released from the necessity of carefully tracking the celestial bodies: their mathematics developed into an art form. But Greek geometry, and particularly its spatial way of viewing things, gave rise to our twentieth-century models of the universe. We still depict bodies travelling in orbits, though the planets are no longer confined to the simple circles the Greeks adored.

The greatest intellectual achievements of New World astronomers are to be found not in geometry but in numerology, or so one concludes after inspecting the available source material: namely a handful of codices which survived the sixteenth-century Spanish conquest. The Maya codices are among the most remarkable. In the figure on pages 60-61, we display a portion of a table from the Dresden Codex of Yucatan, named after the European city in whose library it surfaced over 300 years after the Conquest. It tells us something about Maya knowledge of both the sun and the moon, for it is an eclipse ephemeris which served the function of warning when the face of either primary deity would suddenly vanish from view. The symbols indicated by dots and horizontal bars in the table represent Maya numerals. A dot signifies one; a bar signifies five. Combinations of these symbols form numbers up to 20, the base of the Maya mathematical system. These numbers, moreover, are stacked vertically to create an ordered system of numeration with place-values which, from bottom to top, would read in strict multiples of twenty for any count other than time. It is only for the counting of the days that 360 replaces 400 as the third place-value, probably because the former lies close to the length of the tropical year. Thus the place-values in the eclipse ephemeris are 1, 20, 360 (not 400), 7,200 (not 8,000), and so on. Observe, then, that the numbers across the lower portion of the table (Row A) become, in Arabic notation, 177, 177, 177, 177, 177, and 148 while the numbers in Row B read 6,408, 6,585, 6,762, 6,939, 7,116, and 7,264. [6,585, for example, is represented as $(5 \times 1) + (5 \times 20) + (18 \times 360)$. The number may be recognized as the Chaldean *saros,* an eclipse cycle well known in the Old World because it produces a seasonal recurrence of 35 successive eclipses of the same type.] Observe also that the numbers of Row B are obtained by adding the value of the number



The Greek use of astronomy to express the principles of geometry. Aristarchus determined the distance of the sun from the earth —SE in the drawing — as compared to that of the moon — ME (or M'E) — by solving the right triangle MES. According to him, the measure of angle M'ES — 87° — was determined by the "observation" that it takes 14 days for the moon to pass from last quarter through new phase to first quarter and 14 days to complete a full lunar cycle by moving from first to last quarter. But based upon actual observations, no such difference is detectable. To represent the true situation, angle MEM' should be virtually 180° because the sun is very far away compared to the size of the lunar orbit.

in Row A of the preceding column to the number in Row B directly above it. Thus 6,939 + 177 = 7,116; 7,116 + 148 = 7,264, etc. So the lower columns represent intervals, the upper cumulative totals. The number 177 may be recognized as six lunar-phase months, while 148 represents five moons.

Why did the Maya group the moons in sixes, occasionally adding a five-moon group? A study of eclipse intervals gives the answer. A lunar eclipse occurs when the full moon passes into the shadow of the earth. Conversely, a new moon passing across the solar disk produces an eclipse of the sun. Neither phenomenon can take place unless the earth, moon, and sun lie nearly along a straight line. Such a period of vulnerability to the occurrence of eclipses occurs about every 173 days — a period astronomers call the "eclipse half-year." Maya astronomers must have observed and recorded the dates of eclipses until they recognized a pattern. They then discovered that a period of six moons (177 days) lies close to this interval; an eclipse might therefore occur at every sixth moon. (Ancient Chaldean astronomers were also aware that eclipse warning was facilitated if one grouped full moons in bundles of 5 and 6.) But since accumulated six-moon intervals creep slowly ahead of multiple eclipse half-years, the Maya also recognized that occasionally they would need to substitute a five-moon period to take up the mounting slack. The eclipse table thus seems to function as a means of warning when eclipses might occur. The Maya must have treated such events, which are represented by the grim pictures in the lower halves of the pages, with great seriousness, because of the dire consequences they forebode.

One further point: the lunar table occupies several pages of the Dresden Codex, terminating with a cumulative count of 11,958 days, which is intended to represent 405 lunar months. Taking the quotient of these numbers we conclude that one lunar month, according to Maya determinations, is equivalent to 29.52592 — only 7 minutes short of the modern accepted value! Such accuracy was achieved, of course, through a long series of time-averaged observations. The lunar table also helps us to understand why these people, unlike the Megalithic astronomers of Great Britain, exhibited little interest in sighting lunar alignments along the horizon. Their lunar coursing and eclipse prediction was accomplished quite satisfactorily by simply counting phases.

The remainder of each page of the Dresden lunar table consists of ritual calendar information. Maya astronomers were compelled to fashion the ephemeris to accomodate a whole multiple of their 260-day religious cycle (46 × 260 = 11,960 days). Also, it was very important to the Maya to be able to re-enter the table after it was terminated on the same day name and number in the 260-day calendar. We often find them, like the Greeks, deliberately falsifying empirical fact so that their own intellectual or religious dogmas could be upheld.

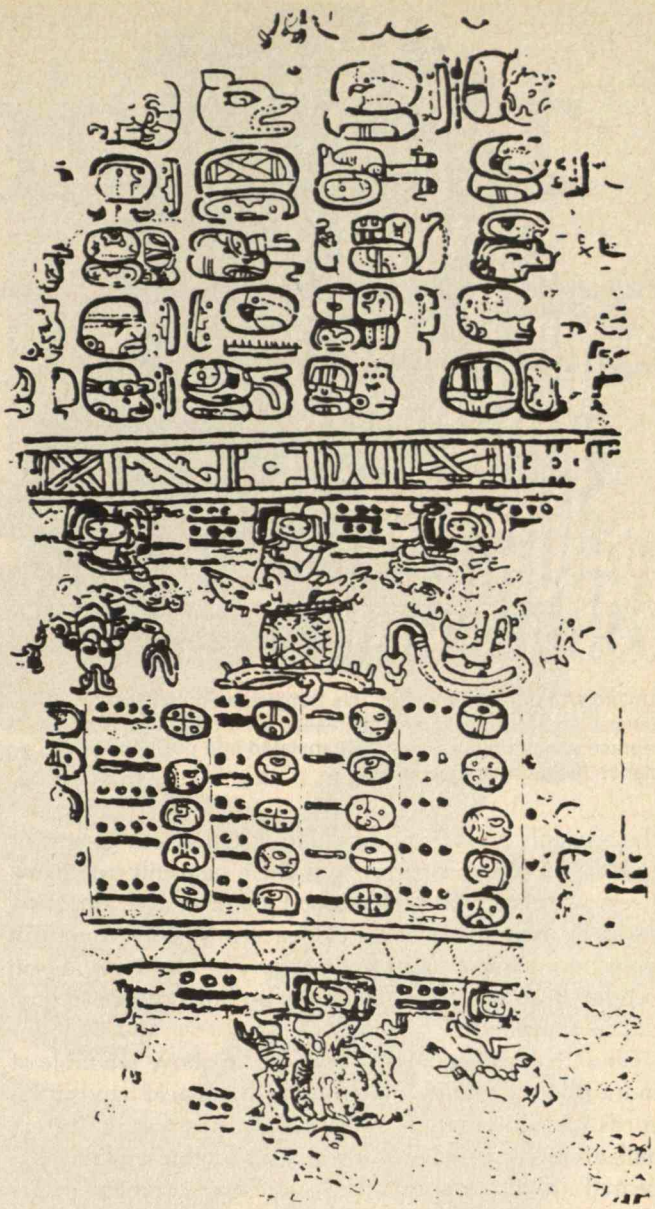
Up to this point, all of the observations and predictions we have discussed pertain to the simple celestial bodies in the natural environment — the sun and the moon. The

planets were more elusive for ancient astronomers. Accordingly, these latter objects, so unpredictable in their courses, became the ultimate presages of the firmament. In particular, the Maya devoted to Venus, the most prominent planet in the sky, a further table in the Dresden Codex. Programatically, the Venus pages (*see the illustration on pages 60-61*) resemble the lunar. Again the lower numerals (Row A) signify intervals — this time the four planetary stations: morning star (236 days) in Column 1 of Row A; evening star (250 days) in Column 3; and disappearance behind and in front of the sun (90 and eight days respectively) in Columns 2 and 4. Though none of these periods represent the true Venus intervals, their sum, 584 days, gives a very close approximation to a complete cycle of the planet.* Even more remarkably, the accuracy improves over the total course of the table, and with the application of a set of corrections supplied by an adjacent table, five iterations of the ephemeris data cause the position of Venus as indicated by the Codex to lie within two hours of the planet's true position. But let us not allow our Western cultural chauvinism to lead us to assume that a Venus "orbit" was being calculated. Time, not space, was the principal medium of expression for all the astronomy gleaned from the Maya codices.

The Venus table in the Dresden Codex is the product of post-Classic (about twelfth-century A.D.) northern Yucatan. The Caracol, a towering cylindrical building at the ruins of Chichen Itza, dates from the same era and domain. Long ago, Maya astronomers peered through the narrow horizontal slots in its turret to obtain the observations that were used to construct the Venus calendar. Today we find that sightlines measured through the Caracol windows and in the base of the tower perfectly frame the extreme setting positions of Venus along the flat Yucatecan horizon. Observations of the place of disappearance of Venus in the west represent an ideal method to calculate when the planet will reappear in the east, undergoing heliacal rising after passing invisibly in front of the sun. Indeed, the prediction of the heliacal rising of Venus seems to be the theme of the table. For the center pictures on each page occur adjacent to the eight-day disappearance before heliacal rise, and they depict various manifestations of the Venus god Quetzalcoatl-Kukulcan throwing spears (his dazzling rays) upon first appearance in the pre-dawn sky. In the lower pictures we see victims impaled by the spears, symbolizing the various evil consequences which emanate from each reappearance of the god.

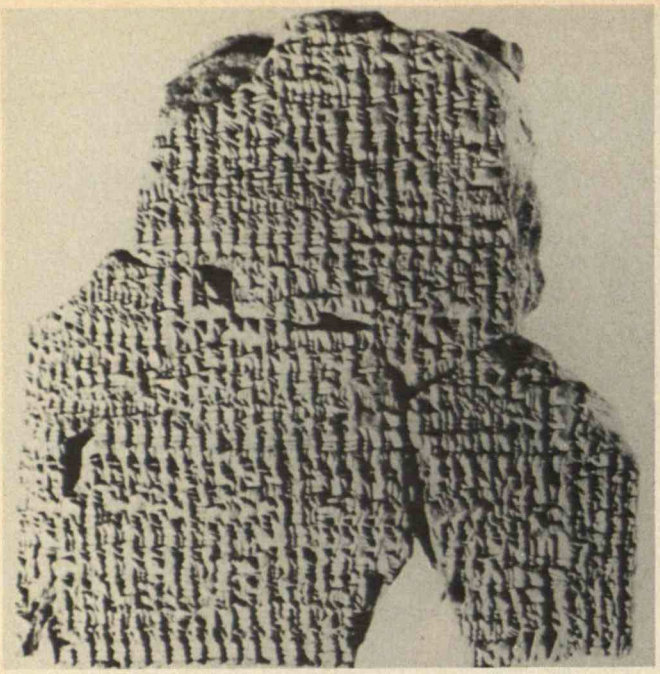
Having briefly inspected the Maya codices, we can see why one eminent Mayanist was moved to remark: "Let's face it, as far as the Maya were concerned, astronomy was astrology." To be sure, the regularities exhibited by the systematic recording of naked-eye observations of the moon and of Venus gave rise automatically to a scheme for predicting their motion. And the system evolved into a self-correcting, self-cleansing mechanism able to produce predictions of ever greater refinement because it was nourished by continued observation of the related events. In this sense, both the Maya and the Old World astronomers were practicing basic science. For the latter, the scientific explanation of the universe was couched in a framework of interlocking orbits, whereas the former strove for celestial harmony by appealing to the cyclical nature of time.

To facilitate the pursuit of planetary phenomena across the celestial globe, any space-oriented astronomer ought to devise a zodiac. After all, the planets as well as the sun and moon all move among the stars along trajectories confined to a thin band which encircles the sky. Here, then, is a way of marking the stations or resting places of



An apparent zodiac from Maya civilization. The illustration is taken from the Paris Codex, and comprises, it seems, a parade of 13 animals that hang from a band of the sky. Though some creatures are effaced from this fifteenth-century document, a scorpion, a serpent, and a tortoise are all easily visible.

*Like that of the lunar table, the length of the Venus table was fixed by both ritualistic and astronomical considerations. Its length, 37,960 days, is made up of 65 Venus cycles, each of 584 days. This period also coincides with a whole multiple both of 260-day cycles and 365-day years. In particular, it is 146 of the former or 104 of the latter. Furthermore, the 236- and 250-day intervals for the Venus stations correspond to 8 and 8½ lunar months, thus suggesting that the Maya astronomers even sought to link together the Venus and lunar cycles.



An Old World planetary text. This Babylonian cuneiform tablet consists of stick-like figures impressed on a clay base. The representative numbers can be translated into positions of the planet Jupiter along the zodiac.

the heavenly gods by reference to different star groups or constellations which make up their heavenly roadway. Every Western culture developed a zodiac and, curiously enough, there exists some evidence in Native American inscriptions (*see the figure on page 71*) that New World people, in spite of their emphasis on horizon astronomy, did so as well.

The Chaldean cuneiform text shown above is a table of motion of the planet Jupiter along a zodiacal band: it records the constellation as well as the position in degrees and arc-minutes where this second-brightest planet appeared after having executed successive complete cycles of its motion relative to the sun. Such tables disclosed minor variations in the position of Jupiter over long periods of time, which enabled Chaldean astronomers to refine their predictions for future Jupiter cycles. Like the Maya, these Old World astronomers attempted to calculate planetary periods from empirical data. But space rather than time was the principal medium in which their observations were couched.

Watching the stars also had its rewards. Indeed, through careful observations, early Old World astronomers determined with precision one of the longest cycles in nature — the 26,000-year period of the precession of the equinoxes. This great cycle in nature is occasioned by the slow movement of the pole of rotation of the earth about the pole corresponding to its plane of revolution around the sun. The ultimate effect is a slow sliding movement of all the constellations. Since the zodiacal star groups were the most closely watched, observers could readily notice that their rising and setting places on the horizon were altered through time. So, too, were the times in each year when they made their first annual appearances. There are thus at least two ways of detecting this slow transformation in the heavens. The Greek astronomer Hipparchus used the latter technique, and it has been suggested that the Mesoamericans used the former, though evidence to conclusively corroborate the argument is wanting.

In this brief review we have offered selected samples to illustrate how pre-technological peoples using only naked-eye observations of the heavens were able to build up ever more elaborate models of the universe. Such models could be used to predict the course of celestial events, but as the observations became more sophisticated, the machinery of prediction was required to yield greater accuracy. Starting with simple observations to chart the annual course of the sun, the ancient astronomers expanded their discipline to include the prediction of eclipses and the decipherment of some of nature's more elusive heavenly periodicities. Such progress is not so different from the evolution of modern science, in which an expanding technology, enabling more accurate observation, forces us to make refinements in the ways we model the behavior of nature. From our comparative study we learn that similarities between these farflung astronomies outweigh the differences. Little wonder that diffusionists have for so long sought astronomy as a haven for their theories about the trans-oceanic migration of ideas. Yet it may be safer to reason that since all astronomical cycles are universal, should not careful observers on both sides of the ocean arrive at similar conclusions about the heavens around them?

The motives for practicing primeval astronomy are multiple and diverse, and they are seen to be combined in all civilizations: they include chronology, agriculture, religion, astrology, civic affairs, and — at least for the Greeks — a curiosity about nature. It is from the early Greek philosophers, whose thoughts were filtered through the Western Renaissance, that we derive much of our present outlook. But to understand fully our systems of thought, we must pause to look back, not merely at scientists of our own direct lineage, but rather at scientists of all ancient cultures. Only then can we appreciate our present-day achievements, as nested among those of the whole human race.

Anthony F. Aveni is Professor of Astronomy at Colgate University. He received a B.A. in physics from Boston University and his doctorate in astronomy at the University of Arizona. Prior to his tenure at Colgate, he served as Acting Director of the Observatory at the University of South Florida. Dr. Aveni's recent activities have centered around research in the field of archeoastronomy, primarily of ancient Mexico. He is editor of two books on archeoastronomy and the author of numerous papers and articles on the subject. A further book, *Skywatchers of Ancient America,* is now in press.

For further reading:

Native American Astronomy, Anthony Aveni, editor, University of Texas Press, Austin, 1977.

Archeoastronomy in Pre–Columbian America, Anthony Aveni, editor, University of Texas Press, Austin, 1975.

In Search of Ancient Astronomies, Edwin C. Krupp, editor, Doubleday and Co., New York, 1977.

"The Mysterious Maya," by George Stewart, *National Geographic Magazine,* 1978.

A Commentary on the Dresden Codex, by J. Eric S. Thompson, *Memoirs of the American Philosophical Society,* volume 93, Philadelphia, 1972.

America's most gifted typewriter.

patented Correction Cartridge

It's the Smith-Corona® Cartridge Ribbon electric portable, and it's the most talented typewriter around.

It lets you change cartridge ribbons in seconds without ever touching the ribbon.

It lets you correct typing errors neatly, quickly, easily with the patented snap-in Correction Cartridge.

And it gives you the largest choice of cartridge ribbons there is—everything from a long-life nylon ribbon for most typing jobs, to a carbon film ribbon in five colors, to give special typing jobs a crisp executive look.

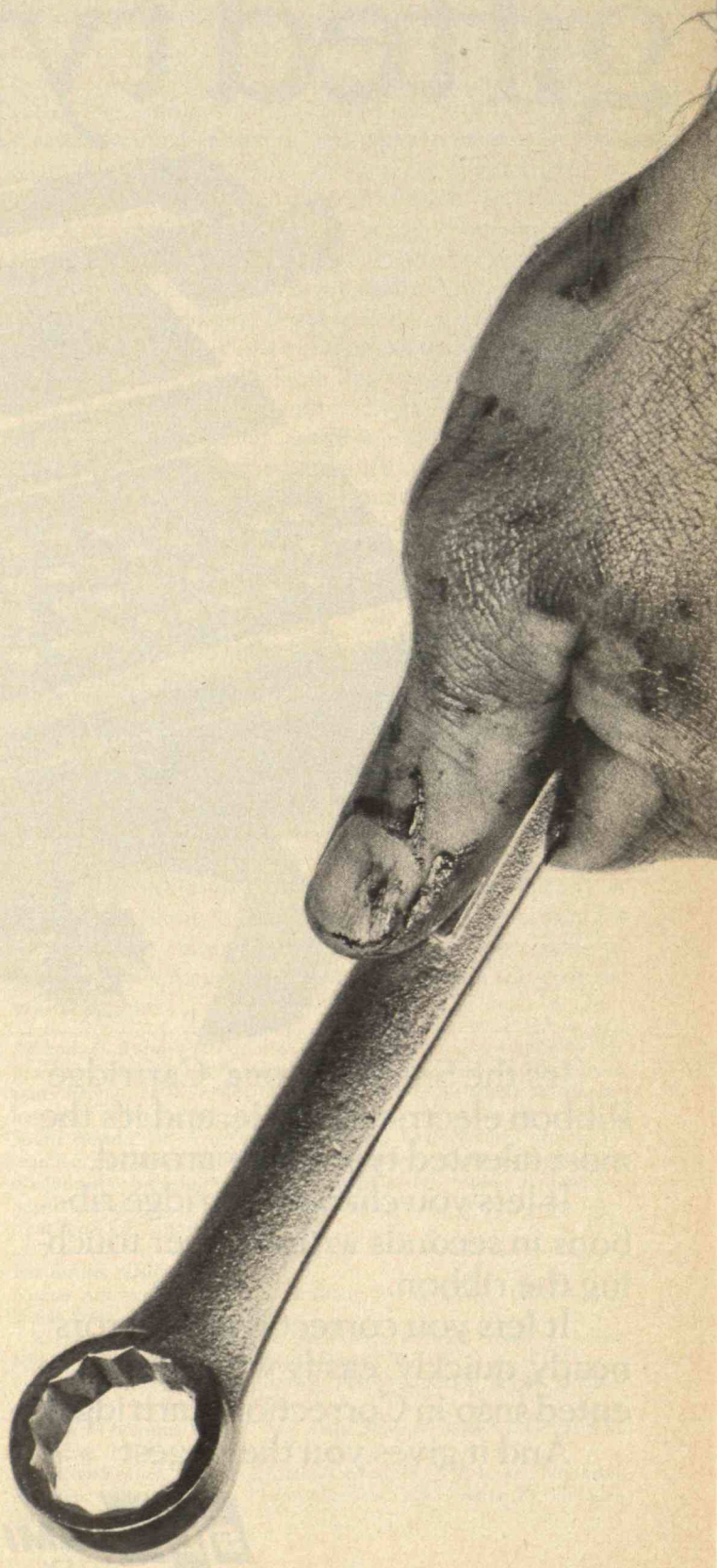
So if you're giving someone a typewriter, take a look at the Smith-Corona portable. Find out why it's America's most gifted typewriter, not only at Christmas but all year round.

SCM® SMITH-CORONA
SCM CORPORATION

The Controversy Over the Health Effects of Radiation

Thomas Najarian

Nuclear workers exposed to low levels of ionizing radiation are contracting cancer at higher than average rates. Either the new data are faulty, or low-level radiation is much more harmful than previously thought.

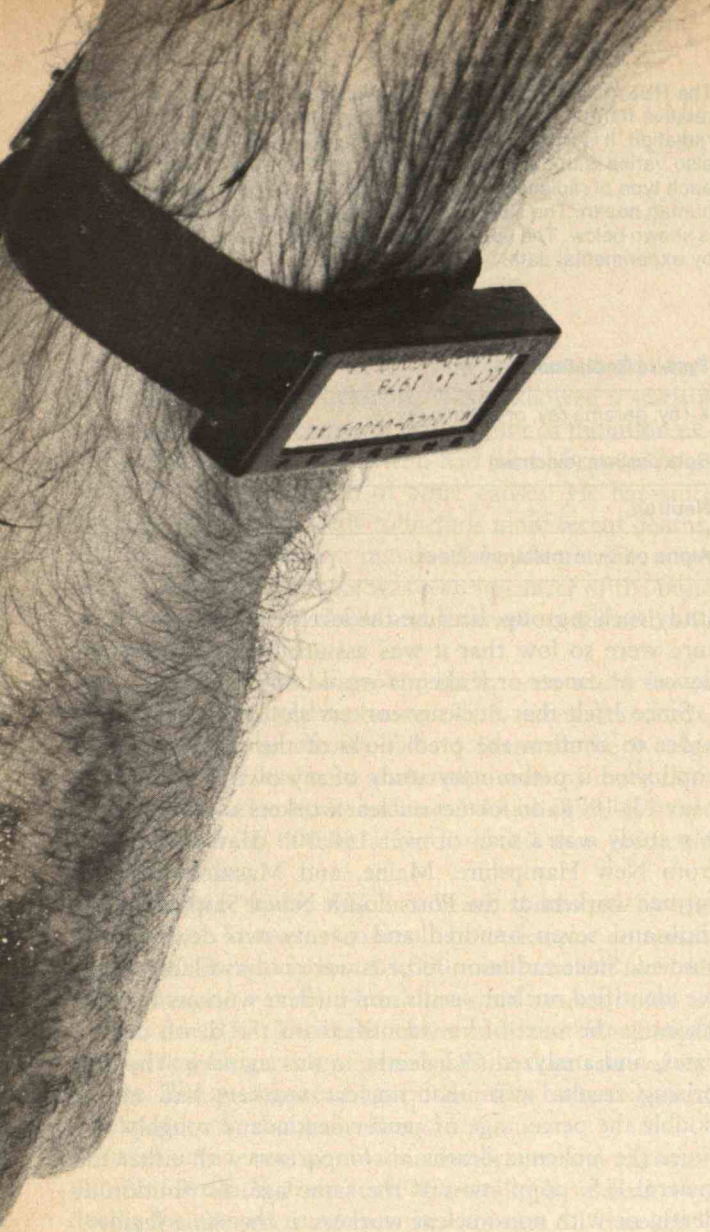


Ever since the discovery of ionizing radiation by Wilhelm Roentgen in 1895, knowledge of the physical properties and biological effects of radiation has increased. By the 1930s, x-rays were known to cause skin burns, bone necrosis, osteomyelitis (infection of the bone), and destruction of the blood-forming elements in the bone marrow; moderate doses of ionizing radiation were associated with a higher incidence of cancer and leukemia about 25 years ago. The accumulation of knowledge about the long-term health effects of low-level ionizing radiation has been slow. Although the long-term health effects are imperfectly understood, they have been assumed to be minimal on the basis of studies on atomic bomb survivors in Japan, American radiologists, and people who have undergone x-ray therapy. Recent data contradict this assumption.

Three new studies have raised a controversy over the effects of small doses of ionizing radiation on biological systems, and the magnitude of those effects. The newer experimental data on humans exposed to what was assumed to be safe doses of radiation indicate results which are much different from those expected. This suggests a major public health problem for nuclear workers today and perhaps for the rest of the world's population in the future. Economic factors are likely to force a controversy over these newer results until massive evidence is marshalled to support the newer studies. If the newer studies are confirmed by additional studies of exposed populations, then the reasons for the excess cancer and leukemia in those exposed to low levels of ionizing radiation will be determined. In this article I will present the newer studies on the health effects of ionizing radiation, explain how these studies add to older data, and suggest how this important controversy can be resolved.

The Basis of Current Safety Standards

In order to understand the basis of the current controversy over the health effects of low-level ionizing radia-



tion, one must first know how the current safety standards were established.

Ionizing radiation is any atomic particle or frequency of electromagnetic radiation which is capable of causing ions, or free radicals, in a material through which it passes. Ionizing radiation does this by expelling an electron from its orbit and leaving behind a charged particle, or ion.

Ions cause most of the physiological damage. Highly reactive ions interact with the molecules of life to change them chemically. If too many ions are produced in a cell or organism, they can alter the enzymes, proteins, mitochondria, and genetic material enough to cause the immediate death of the cell or organism. When the changes are less severe, the organism or cell may survive but harbor within it some irreversible change that may lead to a delayed death (such as from cancer) or that could be passed to future generations of the cell or organism through genetic mutations.

Ionizing radiation is measured for purposes of safety standards by a unit called the Rem (Roentgen equivalent man). Current standards allow for an exposure of up to five Rems per year for workers over the age of 18. These safety standards were established at a level of radiation below which it was believed no significant health effects should occur.

The Rem is dependent upon two factors: the rad (or radiation absorbed dose); and the RBE, or relative biological effectiveness. One rad, a unit of energy, is equal to 100 ergs delivered to a gram of absorbing material. Different types of radiation, even those of equal rad measurement, can cause more or less ion formation and tissue damage. Because all ionizing radiation is not uniform in its biological effects, the Rem is used in measuring human exposure rather than the rad.

The conversion factor between rads and Rems is called the RBE (Rems = rads × RBE). The RBE varies for different types of ionizing radiation, varies for different energy levels of the same type of ionizing radiation, and varies depending on the observed health effect (such as immediate death or eventual cancer induction). The RBE is higher for more damaging types of radiation and lower for less damaging ionizing radiation (*see p. 76*).

The current safety standard of five Rems per year for occupational exposure to ionizing radiation was based on research that includes studies of American radiologists (both before and after measures were taken to reduce radiation exposure in the 1950s), atomic bomb survivors in Japan, and people who had received x-ray therapy for various medical ailments such as acne, enlarged thymus, tonsilitis, and arthritis.

A wrist badge can be worn to monitor radiation exposure. Inside the badge is a thin strip of film that has been treated with two different emulsions in order to record large and small radiation doses. Another strip of film monitors neutron exposure. Radiation darkens the film; the amount of radiation the badge's wearer has absorbed is determined by measuring the density of the image on film. The badge also contains four filters which are used to separate the different types of radiation for identification. (Photo: Ralph Mercer)

The RBE (relative biological effectiveness) is a measure of the relative harm to human tissue done by different types of ionizing radiation. It is higher for the more damaging types of radiation, and also varies with the type of ionizing radiation, the energy level of each type of radiation, and with the radiation's observed effect on human health. The RBE range for some types of ionizing radiation is shown below. The upper limits of the RBEs are still being refined by experimental data.

Type of Radiation	RBE
X-ray, gamma ray, or cosmic ray	1
Beta particle (electron)	1-2?
Neutron	2-8?
Alpha particle (helium nucleus)	8-20?

These studies quite consistently predicted the amount of radiation exposure at which the natural or spontaneous incidence of cancer or leukemia would double. They all predicted that a population exposed to 50 to 100 Rems would exhibit twice the natural incidence of leukemia, and that a population exposed to 300 to 400 Rems would exhibit a doubling of the natural incidence of *all* cancers (*see p. 77*).

The term "doubling dose" is important here. Different cancers vary in their sensitivity to radiation induction. Leukemia, for example, has a lower doubling dose (the dose of radiation exposure which will double the natural incidence of a particular disease in humans) than others. A doubling dose of 400 Rems for all cancers, as indicated by the older studies of radiation exposure, means that a population receiving 400 Rems of ionizing radiation would show a doubling in its incidence of all cancers. If that population received 800 Rems, the incidence of all cancers would go up four times.

If a person were to receive five Rems per year for 40 years, his total occupational exposure to ionizing radiation would be 200 Rems. This means that his chances of developing a fatal cancer would nearly double, and he would be 4 to 16 times more likely to develop leukemia (which has a doubling dose of 50 to 100 Rems). In actual practice in the nuclear industry, the vast majority of nuclear workers receive much less than the five Rems per year allowed.

Nuclear Workers at the Portsmouth Naval Shipyard

One year ago a 63-year-old man was referred to my hospital for an unusual blood and bone marrow disease. We diagnosed his condition as hairy-cell leukemia. During his evaluation, he asked me if his leukemia could have had anything to do with some work he had done nearly 20 years before. His occupation before retirement had been as a nuclear welder at the Portsmouth Naval Shipyard, a naval facility where nuclear submarines are built, overhauled, and refueled. I learned that his total lifetime occupational exposure at the shipyard was less than two Rems, so I told him that I did not think that his leukemia was likely to have been caused by his exposure (older studies on humans would have predicted that his chances of developing leukemia after two Rems exposure would be less than 4 per cent higher than the usual odds of developing leukemia.)

The patient mentioned that some younger fellow nuclear workers on the *Nautilus* had died. Intrigued, I searched the literature to find studies on people who worked on the overhaul of nuclear reactors, but found none. Neither had the Navy conducted any follow-up studies on nuclear workers. No one had felt the need to study such a group, because the levels of radiation exposure were so low that it was assumed that higher incidences of cancer or leukemia would not be found.

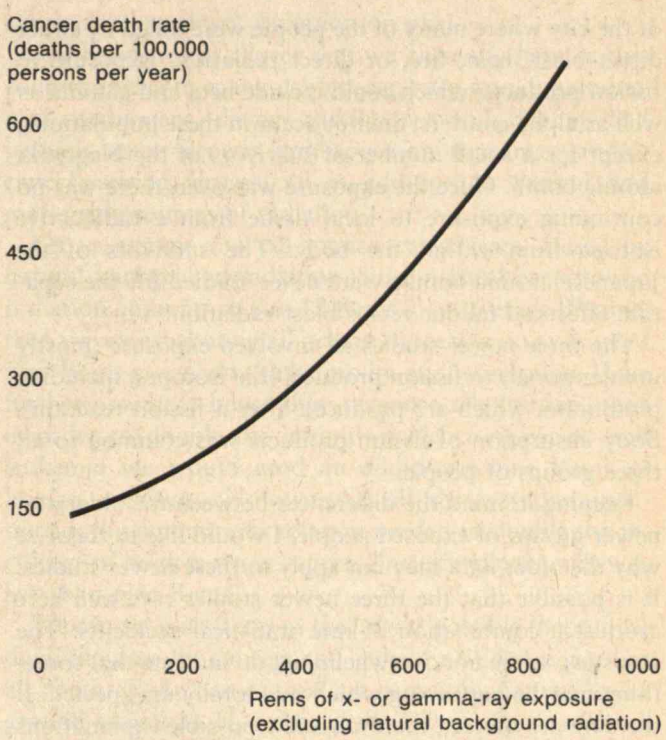
Since I felt that nuclear workers should be studied in order to confirm the predictions of the older studies, I conducted a preliminary study of my own (*The Lancet*, May 13, 1978) on former nuclear workers at Portsmouth. My study was a scan of over 150,000 death certificates from New Hampshire, Maine, and Massachusetts for former workers at the Portsmouth Naval Shipyard. One thousand seven hundred and twenty-two deaths were studied. Since radiation records were not available to us, we identified nuclear versus non-nuclear workers by telephoning the next-of-kin identified on the death certificates, and analyzed 592 deaths in this manner. The surprising results were that nuclear workers had nearly double the percentage of cancer deaths and roughly five times the leukemia deaths in comparison with either the general U.S. population of the same age distribution at death, or with non-nuclear workers at the same facility.

Although I did not have specific information on individual radiation exposure, I did have information on the exposure of the entire population of nuclear workers in the Naval Nuclear Propulsion Program. These records indicate that my patient with leukemia had a total lifetime radiation exposure at the shipyard that was rather typical of all of the nuclear workers. The average worker had an annual exposure of about 0.2 Rems. Most lifetime exposures were less than five Rems. According to the Navy, the highest total lifetime exposure of any nuclear worker in its program is about 50 Rems. Thus a higher percentage of cancer and leukemia deaths appeared in these nuclear workers than was predicted by the older studies of the effects of radiation in man.

Other Studies on the Effects of Low-Dose Radiation

My results do not stand alone against a wide body of knowledge that say that the results could not be true. Shortly after I started my research, a study was published on a group of workers at a Washington atomic plant in the November, 1977, issue of *Health Physics* by Dr. Thomas F. Mancuso. This study and another ongoing study of soldiers who were involved in the testing of an atomic bomb in Nevada lent credence to my results.

The actual dose-response curve observed at high doses of x- or gamma-ray exposure in humans. Note that 400 Rems of x-ray exposure are needed in order to double the expected or "natural" cancer death rate of 150 cases per 100,000 people per year. Note also that in the dose range of less than 200 Rems, a roughly linear dose-response curve is assumed. Human data on exposures of less than 50 Rems of x-ray exposure suggests that the curve in this range is also correct.



The study by Dr. Mancuso on the workers at the Hanford atomic plant in Richland, Wash., showed a statistically significant difference in the amount of radiation exposure among the workers who had died of cancer compared to those who died of other causes. He has since widened his original study to include more recent deaths, and the differences have remained significant. The most notable increase in cancer was seen in cancer of the bone marrow (multiple myeloma and leukemia combined) and cancer of the pancreas.

The exposures in his group, again, were much lower than those permitted by current U.S. safety standards, being on the order of only 1 to 15 Rems on the average per worker. He has now analyzed a total of more than 5,000 deaths. His results indicate "doubling doses" that are much less (by at least a factor of ten) than predicted by older studies.

The second study, which is being conducted by the Center for Disease Control in Atlanta, concerns "Smokey," in which about 3,000 men marched into the fallout area of a small, Hiroshima-sized atomic bomb in Nevada in 1957. These men wore radiation film badges and carried Geiger counters to measure dose rates of exposure. The average readings of their film badges showed an exposure of about one Rem.

Based on average population incidences, the expected number of deaths from leukemia would have been two during the elapsed time since the exposure to "Smokey." Instead, eight deaths from leukemia have been found so far. (This difference is statistically significant, though the reliability of statistics is less with such small numbers in both the observed and expected categories. This question of significance should be resolved when some of the other nuclear test subjects are studied. Nearly a half million men, civilian and military, were exposed in such tests, but in different ways with each test.)

The results of my own and the other two studies are pictured graphically on p. 78. Note the marked difference in the results of the newer studies when compared to those extrapolated from older data with much higher doses of radiation. What do these newer results mean? Is the older data on radiation exposure wrong or are the newer studies in error? What can be learned from this new information?

Understanding the Low-Dose Radiation Controversy

In order to understand how it is that the older studies can show results so much at variance with the newer data, one must understand the fundamental differences between the two groups of studies. The older studies had a number of common characteristics:

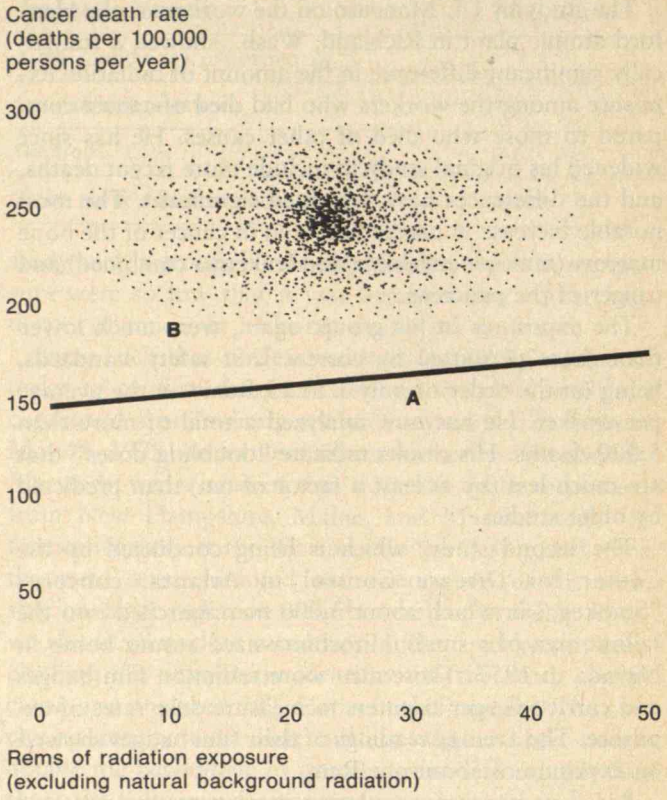
☐ In all cases, the exposure was in the moderate-to-high dose range (50 to 5,000 Rems). The doses in some cases (atomic bomb survivors) were high enough at a single exposure to kill a large fraction of the population.

☐ The dose rates (Rems per hour) were also very high. Animal experiments have indicated that for certain cases, for example, the dose needed to kill half the test animals, a given dose is *less harmful* if the dose rate of exposure is *lower*. Seemingly, this would add a margin of safety for occupational exposure to radiation in which the dose rates are lower than those for atomic bomb survivors.

☐ The older study populations, because they lived 20 to 50 years ago, had lower natural incidences of cancer and leukemia than populations in industrial America today; other carcinogens (with the exceptions of cigarette smoking and heavy alcohol intake) may not have been present in the exposed populations.

☐ Radiation exposure of the subjects in the older studies was relatively "clean," and was caused by mostly gamma- or x-rays whose RBE is one. With the exception of the atomic bomb survivors, all of the other studies mentioned above measured effects of radiation which occurred from a source outside of the body from an x-ray or gamma-ray-emitting source. The "fallout" from the atomic bombs accounted for only a small fraction of the total Rem count in the survivors. In fact, the Hiroshima bomb had practically no fallout, while the Nagasaki bomb created only a small amount of fallout in a very small area

The dose-response curve extrapolated in a linear fashion through the low dose range to zero radiation exposure is shown as A. The stippled area (B) represents the observed results of the newer studies of low-dose radiation effects in humans, an effect which the older theories do not support. Perhaps exposure to a particular alpha-emitting, internally deposited isotope such as plutonium is responsible for the excess cancer at very low Rem counts.



of the city where many of the people were killed by either direct blast, heat, fire, or direct radiation. Exposure to fission products, which could include beta and gamma as well as alpha emitters, did not occur in these populations, except for a small number of survivors of the Nagasaki atomic bomb. Once the exposure was over, there was no continuing exposure to local tissue from a radioactive isotope from within the body. The survivors of the Japanese atomic bombs were never studied for the separate effects of fallout versus blast radiation.

The three newer studies all involved exposure (mostly unintentional) to fission products (the isotopes, including plutonium, which are produced after a fission reaction). Body absorption of fission products was common to all three groups of people.

Keeping in mind the differences between the older and newer groups of exposed people, I would like to theorize why the older data may not apply to these newer studies. It is possible that the three newer studies reviewed here are just a combination of rare statistical accidents. The statistics, while not overwhelming, do indicate that something may be happening which was totally unexpected. If the data are correct, there are a few possible explanations for the marked differences between the observed results and the expected results:

☐ Chronic, low-dose radiation exposure (which includes the "Smokey" test subjects, who continued to have low-level exposure from internally deposited radioactive isotopes long after their exposure to the bomb fallout) may induce cancer by a different mechanism. Short-term, high-dose radiation could conceivably cause death to some cells which, had they lived, would have had the potential to become malignant.

☐ Radiation-induced cancer could occur more readily today in our multiple-carcinogenic environment than it did when the older studies were conducted. Radiation sensitivity is known in many cases to be more severe in the presence of other-carcinogens, such as in people who receive highly reactive drugs in combination with radiation therapy for the treatment of malignancy. In one study conducted by doctors at the National Cancer Institute, the risk of developing second malignancies was more than 20 times the expected amount when both radiation and multiple drug chemotherapy were used for treating Hodgkin's disease, as compared with an increase in risk of only three to four times when using either therapy alone.

☐ Perhaps workers exposed to radiation from nuclear power plants or from fission products generated by these plants receive contamination from a particular isotope (such as plutonium) in such minute quantities that its detection in nuclear workers is overlooked by the current methods of measuring radioactive contamination in these workers.

☐ Nuclear workers may be receiving more radiation than the records at one plant indicate: workers might swap radiation badges in order to qualify for overtime work; a nuclear worker might become overexposed by traveling from one plant to another and receiving his maximum quota for a three or six month period at each plant in just one week; radiation accidents might be inaccurately reflected by the badge reading or incorrectly recorded in official records; radiation to the arms or legs could be much higher than badge readings, because badges are located on the chest; or deposition of internal emitters may be contributing to a higher effective Rem count than current estimates allow. (Dr. Mancuso's study excluded internal contamination as measured by urine counts for radiation and total body counts for radiation as the sole cause of excess cancer in his study, but the possibility remains that internal emitters played a part in increased cancer risk.)

☐ Some other carcinogen, as yet unidentified, may be responsible for the excess cancer risk found in each of the three studies reviewed here.

One other factor that adds to the controversy over the newer data is the effects of natural background radiation on humans. In many ways the role of natural background

radiation fits the older data on radiation effects on man better than it does the newer studies, perhaps because fission products do not exist in such large quantities in nature as they do in the environment of nuclear workers.

Natural Background Radiation

Natural background radiation is ionizing radiation which occurs naturally on earth, and does not include any man-made radiation. Thus, fallout from nuclear testing or emissions from nuclear plants are not part of natural background radiation, even though we are all exposed to these sources in varying amounts. Likewise, medical x-rays (both diagnostic and therapeutic) cannot be considered part of the natural background radiation. Natural sources of ionizing radiation include cosmic rays (filtered by the earth's atmosphere), gamma rays from naturally occurring radioactive isotopes in the earth (greater in some regions of the world such as in areas of Brazil, France, and India), and internal radiation from isotopes (such as potassium 40) in our own bodies.

In most areas of the U.S. the natural background radiation averages about 150 milliRems per year. This means that the average person would be exposed to about 6 to 12 Rems of ionizing radiation from natural sources during his lifetime. When one speaks of "low-dose" exposure to ionizing radiation, one is talking about a dose from occupational or other exposure (medical, etc.) of between 1 and 50 Rems. As an example of an average "low-dose" exposure, one could take the three different populations of exposed people that I have just discussed. The study that I conducted on the nuclear workers at the Portsmouth Naval Shipyard covered a population of Naval nuclear workers who had average lifetime occupational radiation exposures of between 2 and 10 Rems. In the entire Naval Nuclear Propulsion Program, no worker, according to official naval records, has ever had more than 50 Rems total lifetime exposure to ionizing radiation. In the Center for Disease Control's study of the 3,000 soldiers involved in Smokey, the average total exposure was about one Rem. The workers at Hanford had average lifetime exposures of between 1 and 15 Rems. In all cases, an excess of bone marrow cancers was found, and in Dr. Mancuso's and my own studies, an excess of all cancers was also found among the group with higher radiation exposure.

When one considers the role of natural background radiation as a cause of cancer and leukemia, one can develop a strong theoretical argument against a significant cancer or leukemia induction by "low-dose" ionizing radiation. The word "theoretical" is important to remember, because none of the arguments against such an effect are based on actual experimental observation of the effects of "low-dose" radiation on man.

The incidence of cancer that we currently have in this country is due to many causes: cigarette smoking, industrial carcinogens, dietary carcinogens and alcohol, and perhaps some genetic predisposition to cancer and/or cancer-causing viruses, all in addition to natural and man-made sources of radiation.

Let us assume that all human cancers are caused by natural background radiation. Since natural background radiation amounts to 6 to 12 Rems in an average lifetime, then we are attributing all human cancers to an average of nine Rems of ionizing radiation by our assumption. If we further assume a linear dose-response relationship, then in order to double the natural incidence of cancer and leukemia we would need an additional nine Rems of human exposure. However, in all three studies mentioned, the amount of radiation needed to double the incidence of bone marrow cancers (including leukemia) was less than nine Rems.

We can set nine Rems as the *lowest* possible theoretical doubling dose for cancers and leukemia by assuming that all "natural" human cancers are caused by natural background radiation. However, if we adopt a more realistic assumption and attribute to natural background radiation only 10 per cent of all cancers and leukemias, then it must follow that 10 per cent of our "natural" incidence of cancer and leukemia is caused by nine Rems of natural background radiation. This assumption is more realistic because we know that there are other causes of cancer. If nine Rems are responsible for 10 per cent of the "natural" incidence of cancer and leukemia, then it follows that much more than nine Rems of additional exposure would be needed in order to double that incidence.

This theoretical argument strengthens the argument against low-dose occupational exposure to radiation as the cause of the excess cancer and leukemia which have recently been observed in nuclear workers.

Why So Much Controversy?

The fundamental reason for the controversy is that each of the newer studies points to an effect which should not be there. If the effect is real, the production of energy and current procedures in the Naval Nuclear Propulsion Program will almost certainly be affected. Billions of dollars in compensation money could be demanded from former and current nuclear workers — over a million people. The problem of nuclear waste disposal would be magnified since the contamination from wastes and normal radioactive effluents from nuclear power plants could be much more dangerous than previously thought. So, there are good reasons to approach the subject carefully, because ultimately many lives will be affected.

A previous estimate, based on old data of radiation effects in man, places the number of extra cancer deaths expected from an all nuclear energy economy in the U.S. in the future at 30,000 deaths per year. This compares with the current number of cancer deaths of slightly under 400,000 deaths per year in the U.S. If this estimate is off by a factor of ten or more, the number of extra cancer deaths could double from an all-nuclear energy economy. Thus, the precise knowledge of what to expect from increased exposure to the public of radioactive wastes as well as from exposure to workers in the industry is needed in order to weigh the risks and benefits of nuclear energy versus other forms of power generation.

Since these three studies show something which theoretically cannot exist, attempts have been made to either find fault with the studies or reanalyze the data to explain away the observed results. Epidemiological studies and the arguments over their validity can be confusing, so I will explain some things which should help the reader to understand the controversies as they arise.

Both Dr. Mancuso's study and my own are proportional mortality studies, each in a slightly different form. "Proportional mortality" means that the analysis covers only the deaths that have occurred, and compares these deaths in the experimental group with the deaths in a suitable control group.

In Dr. Mancuso's study, the experimental group consists of the deaths that occurred to workers who received slightly larger amounts of radiation than those in the control group. Both groups received radiation in the "low-dose" range as defined previously. He found a higher percentage of cancer deaths in the slightly more highly exposed group. Some critics of his study have reanalyzed his data using a comparison of death rates for cancer in the two groups. The difference between using death rates and proportional mortality is that with death rates, one takes into account the entire working population at the plant both living and dead. A death rate for a particular disease is defined as the number of annual deaths among a total population broken down by age group and usually expressed as a number per 100,000 people per year. The proportional mortality study looks at deaths alone, without regard to the number of living people from whom the deaths occurred, and compares the percentage of people who die from various causes such as cancer or heart disease in an experimental group against a control.

In general, a death rate study is felt by most to represent a more complete picture of the health of a population. The table at the right shows what can happen if one uses proportional mortality alone in studying the health of a group of people.

Proportional mortality alone would seem to show that the experimental group had less of a cancer problem than the control group. However, a look at the death rates indicates that it only appears that the experimental group has fewer cancer deaths: the experimental group had so many more non-cancer deaths than the control group that the percentage of cancer deaths among the experimental group was less (20 per cent) than the percentage in the control group (25 per cent), even though more cancer deaths (800) actually occurred in the experimental group than the control (500).

There is one major drawback to using a death rate study when looking at any study population, and that is the choice of a control group. Problems associated with a control group are related to the elimination of all variables except the variable to be studied. In both Dr. Mancuso's study and my own, a comparison was made between two similar groups. In my study, nuclear workers could be compared to non-nuclear workers who did similar work (welding, chipping, pipefitting, etc.), except without radiation exposure. In Dr. Mancuso's study, deaths of workers with high badge readings could be compared to deaths of workers with lower badge readings at the same facility. In both cases, internal controls — comparisons with people of the same age and sex distribution working in the same facility — were made.

Some critics of Dr. Mancuso's study point out that when death rates are used instead of proportional mortality, the workers at the Hanford plant have a lower

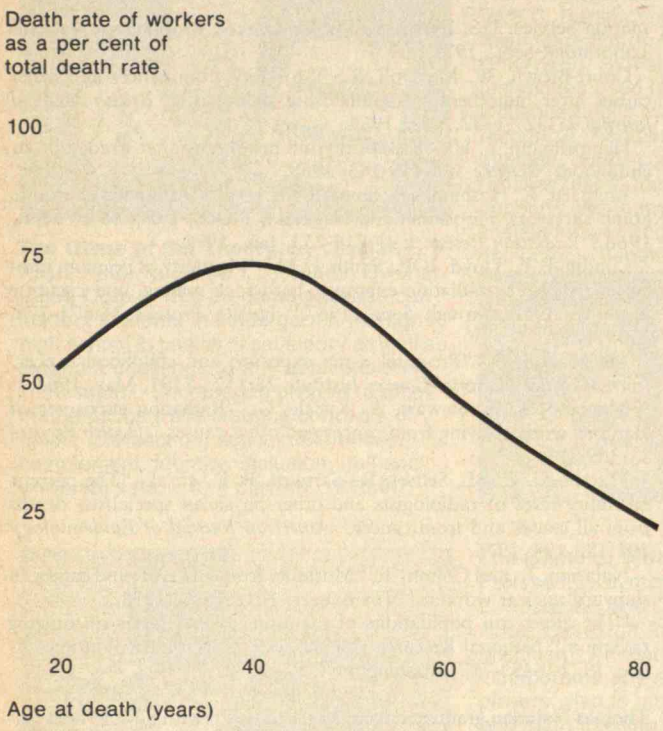
Control population:
death rate versus proportional mortality

Total people:	100,000
Total deaths in two years:	2,000
Number of cancer deaths:	500
Number of non-cancer deaths:	1,500
Death rate (all deaths):	1,000/100,000/year
Death rate (cancer):	250/100,000/year
Death rate (non-cancer):	750/100,000/year
Proportional mortality for cancer:	500/2,000 = 25 per cent

Experimental population:
death rate versus proportional mortality

Total people:	100,000 (consisting of the same age, sex, etc. as the control group)
Total deaths in two years:	4,000
Number of cancer deaths:	800
Number of non-cancer deaths:	3,200
Death rate (all deaths):	2,000/100,000/year
Death rate (cancer):	400/100,000/year
Death rate (non-cancer):	1,600/100,000/year
Proportional mortality for cancer:	800/4,000 = 20 per cent

The "healthy worker effect" influences the comparison of the death rate of the working population with the death rate of the general U.S. population of the same age and sex. A working population is healthier than the general population, particularly for the youngest and oldest workers. Thus, unless an industry or occupation is especially unhealthy or dangerous for the workers, the employed group will have a lower death rate than does the general population.



cancer and non-cancer death rate compared to an age and sex matched control group of U.S. white males. Although this might sound like a reasonable comparison, it is not valid to compare the vital statistics of the U.S. population as a whole to a group of people who at some time are employed.

The discrepancy between the death rates of an occupationally employed group and a matched group of all U.S. people is known as "the healthy worker effect" (*see above*). The fact that a person is healthy enough to work puts him in a selected group which does not compare in mortality rates for any disease compared to the U.S. population. The general U.S. population is not an appropriate control because it includes people who are ill or dying, the chronically disabled, alcoholics, etc. Most groups of working people who are studied are found to have death rates that are only 50 per cent or so of the death rates for an age and sex matched control of the general U.S. population.

You may see at times that a government agency has announced that a particular company's workers have a high death rate for some form of cancer. The company will often report that they have analyzed the data and found that their workers' death rate for the particular disease is no different than the death rate for people in the surrounding area (implying that everyone in the area has a higher than usual death rate for the disease). What they are really telling you is that their workers have double the expected death rate for the disease in question when an appropriate control group is used for a comparison instead of the control group of the general (working and unworking) population.

When Dr. Mancuso's data were analyzed using death rates of higher exposed workers compared with lower exposed workers (both groups falling in the range of exposure which I have been calling "low-dose" radiation exposure), the differences between the two groups for bone marrow cancer and cancer of the pancreas still stand as statistically significant.

A death rate study with the workers at nuclear shipyards using the nuclear workers as compared to non-nuclear workers at the same shipyard in similar occupations will take at least two or three years to complete, according to officials in the Center for Disease Control who are conducting just such a study at this time in response to my prelimary report in *The Lancet*. One must remember, also, that an accurate study (which will include tracking down the whereabouts of some 25,000 former and current workers) will have to identify nearly all of the deaths that have occurred. Otherwise, an artificially low death rate will result. If only 80 per cent of the dead people are located by the Center for Disease Control's methods, then the death rates will be only 80 per cent of the actual death rates.

Will the Controversy be Resolved?

As long as five years after the discovery of deaths due to massive accumulations of radium and mesothorium in radium dial painters (who had the habit of placing radium coated paint brushes into their mouths to sharpen the tip while painting), a New Jersey company that employed the women continued to deny that the deaths of many young women with similar symptoms (not seen as a symptom complex with any known disease at that time) had anything to do with employment at the factory. The same self-interest of industry prevails today with regard to health hazards of anything related to an industry. The cigarette companies, despite large accumulations of data that cigarette smoking is one of the worst health hazards faced by Americans today, continued for years to deny that any hazard existed. Roughly 300,000 Americans are killed prematurely each year by cigarette smoking, dying with an average loss of life expectancy compared to non-smokers of between 5 and 20 years.

The federal government and nuclear power industry are much larger forces with much at stake. The amount of investment in nuclear energy and its importance cannot be overstated. Nuclear power seems, by many energy experts, to be the only viable alternative to a dwindling fossil fuel supply and dependence on foreign oil. Therefore,

there are very powerful interests that hope that there are minimal health hazards to the use of nuclear energy. These factors are likely to force a controversy to continue, perhaps even in the face of overwhelming evidence that substantial hazards exist which are worse than the alternatives to nuclear energy generation.

That overwhelming evidence is not available today. Remember that the particular population groups that work in the overhaul and refueling of nuclear reactors have been doing this for less than 20 years. Since the latency for cancer for low-dose radiation can vary from 8 to 40 years, it is still too early to see the effects on workers except for the few people who did the earliest work in the industry. Portsmouth was the first shipyard to overhaul nuclear submarines. The private nuclear industry is just now old enough for meaningful studies to be undertaken. The likelihood that nuclear workers will not have as dramatic a shortening of life expectancy as cigarette smokers will also make the resolution of the controversy over the health effects of low-dose radiation take longer.

Although I have discussed mostly the cancer-causing effects of radiation, I do not mean to ignore the genetic effects of ionizing radiation. In many ways, this is a separate, and more complicated topic. Mutations have been shown to occur in plants and animals with increased frequency with very small amounts of ionizing radiation, on the order of one Rem. Recessive mutations may be carried for generations without showing any visible effects on offspring because of the relatively low probability of radiation causing mutations in a pair of genes controlling a single process. Studies in humans will likely not tell the whole story for many generations.

The only way to make informed decisions about any new technology, nuclear or otherwise, is to measure its impact including all risks and benefits. Whenever possible, studies of health and environmental effects should be done by impartial parties who are willing to let the results fall where they may. Stopping data collection at a point where the results are not quite statistically significant and calling the results negative will not do.

We have now had enough experience with the occupational exposure to low-dose radiation to study its effects on humans (at least the cancer induction effect) with a massive followup study of hundreds of thousands of workers which could take ten years to complete. There is an urgency to do this before we become totally committed to nuclear power.

References

Arseneau, J. C., Canellos, B. P., Johnson, R., et. al., "Risk of new cancers in patients with Hodgkin's disease," *Cancer* 40:1912, 1977.

"A 20-year review of medical findings in a Marshallese population accidently exposed to radioactive fallout," National Technical Information Service: U.S. Department of Commerce, Brookhaven National Laboratory, Sept., 1975.

Court-Brown, W. M., Doll, R., "Mortality from cancer and other causes after radiotherapy for anklosing spondylitis," *British Medical Journal* 2:1327-1332, Dec., 1965.

Hempelmann, L. H., "Risk of thyroid neoplasms after irradiation in childhood," *Science* 160:159-163, 1968.

Ishimaru, T., Hoshind, T., Ichimaru, M., et. al., "Leukemia in atomic bomb survivors, Hiroshima and Nagasaki, 1 Oct., 1950, to 30 Sept., 1966," *Radiation Research* 45:216-233, Jan., 1971.

Lundin, F. E., Lloyd, J. W., Smith, E. M., "Mortality of uranium miners in relation to radiation exposure, hard rock mining, and cigarette smoking, 1950 through Sept., 1967," *Health Physics* 16:571-578, 1969.

MacMahon, B., "Pre-natal x-ray exposure and childhood cancer, *Journal of the National Cancer Institute* 28:1173-1191, May, 1962.

Mancuso, T. F., Stewart, A., Kneale, G., "Radiation exposures of Hanford workers dying from cancer and other causes," *Health Physics* 33:369-385, 1977.

Matanoski, G. M., Seltser, R., Sartwell, P. E., et. al., "The current mortality rates of radiologists and other physician specialists: deaths from all causes and from cancer," *American Journal of Epidemiology* 101:188-198, 1975.

Najarian, T., and Colton, T., "Mortality from leukemia and cancer in shipyard nuclear workers," *The Lancet:* 1018-1020, 1978.

"The effects on populations of exposure to low levels of ionizing radiation," National Research Council, U.S. Government Printing Office, 1972-0-489-797, Washington, D.C., 1972.

Thomas Najarian graduated from M.I.T. in 1970 with S.M. in mechanical engineering. He obtained his M.D. from the Harvard Medical School in 1974. Dr. Najarian was recently a fellow in hematology at the Boston V.A. Hospital, where he also completed his internship and residency. He soon will return to Boston V.A. Hospital to continue practice in internal medicine.

Games for Thinkers

from WFF'N PROOF publishers

The emphasis is not on what to think, but how to think!

The Game of Set Theory, by Layman E. Allen, Peter Kugel (M.I.T.), Martin Owens (Mitre Corp.). This 30-game package can instruct students in kindergarten through high school in basics of set theory as well as extend a challenge to any adult exploring "new math." Encourages players to enjoy mathematics while learning concepts of union, intersection, logical differences, complement, identity, inclusion, null and universal sets. 2 to 4 players. **$10.00***

The Propaganda Game, by Lorne Greene (N.B.C. Paramount Studios), and Robert Allen (Director of Academic Games, Nova University). Students learn the fascinating techniques used by professionals to influence public opinion by learning to recognize "bandwagon" appeals, faulty analogy, out-of-context quotes, rationalization, technical jargon, emotional appeals, and many more. Fascinating for social studies, English, problems of democracy, debate. 2 to 4 players. **$11.00***

The Game of Creative Mathematics, by Layman E. Allen. Our most popular game of mathematics. Five-game kit for use in intermediate grades through high school. Includes arithmetic operations such as addition, subtraction, multiplication, division, exponents and radicals in a variety of number bases. Like chess, the game can be as simple or as complex as the players make it. 2 to 4 players. **$10.00***

The Game of Modern Logic, by Layman E. Allen, (Professor of Law and Research Social Scientist, University of Michigan). The original game of symbolic logic. Twenty-one-game kit that starts with speed games that challenge intelligent adults. The kit provides entertainment and practice in abstract thinking relevant for philosophy, mathematics, English, and computer programming for junior and senior high school. 2 to 4 players. **$13.00***

The Game of Word Structures, by Professors Layman E. Allen and Frederick L. Goodman, and Doris Humphrey and Joan Ross, Research Associates (University of Michigan). An instructional game that incorporates any aspect of words that players wish to introduce. Players practice and learn spelling, counting, grammar, phonetics, word roots, inflectional endings, prefixes and suffixes. For children and adults. 2 or more players. **$10.00***

The Game of Science and Language (a simulation of scientific method and generative grammars), by Layman E. Allen and Joan Ross (University of Michigan) and Peter Kugel (M.I.T.). Through inductive reasoning, players learn scientific method of inquiry and gain skill in organizing, analyzing, and synthesizing data while engaged in an intriguing game of linguistics. For teenagers and adults. 2 to 4 players. **$13.00***

Configurations

Number Puzzles and Patterns for All Ages, by Harold L. Dorwart (Professor of Mathematics, Trinity College). A series of ingenious geometric and mathematical problems that will delight and challenge those who enjoy careful reasoning. Suitable for junior and senior high school levels. If you prefer solitaire, this one is for you. One player **$6.75***

WFF 'N PROOF Games, 1490-DX South Boulevard, Ann Arbor, Mich. 48104

____	a. WFF'N PROOF (logic)	$13.00*	____	f. Configurations (geometry)	6.75*
____	b. Queries 'n Theories (sci. & lang.)	13.00*	____	g. On-Words (word structures)	10.00*
____	c. Equations (mathematics)	10.00*	____	5-game special (a-e)	49.95*
____	d. On-Sets (set theory)	10.00*	____	6-game special (a-f)	55.95*
____	e. Propaganda (social studies)	11.00*	____	7-game special (a-g)	64.95*

* Includes postage and handling

My check is enclosed for: _____

Name _____

Address _____

City _____ State _____ Zip _____

A Disturbing Report from Michigan

Allan Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Mathematics at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.

Three items of interest have come this month:

William Butler reports a misprint on his problem, **JUN/JUL 1.** See the "Solutions" section below.

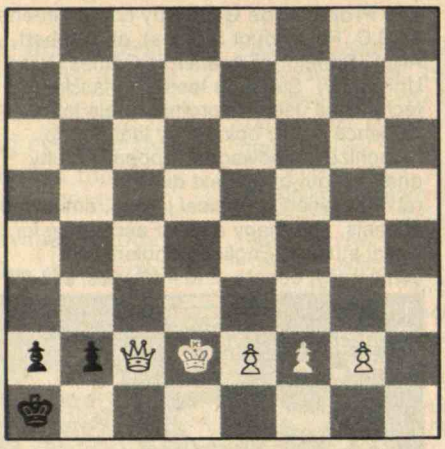
Dr. Frank Rubin reports, "I am embarking upon a new project which I think will be quite exciting. Starting next September, I will be running a mathematics contest for high school classes. The contest will be designed so that entire classes will be the entrants. The problems will be large enough so that they can be solved by dividing the work up among many students working in parallel. I am seeking both problems and judges for the contest. If any 'Puzzle Corner' readers wish to help, they should contact me directly" (59 De Garmo Hills Road, Wappingers Falls, N.Y. 12590).

Finally, J. Coble, of the Population Studies Center of the University of Michigan, sends a disturbing report: "A group of us here waste inordinate amounts of time solving your silly problems. We thought you should know that there are many from whom you may never hear whose careers are being jeopardized in this manner. Keep up the good work."

Problems

NS 13 This one was first published as **1974 JUNE 5,** submitted by Gary Ford:
Two large coins and six small coins are placed on a table, each just touching its neighbors as shown in the sketch at the right. What are the relative diameters of the coins?
When this problem appeared in 1974, excellent approximations (using Newton-Raphson) were given. The proposer has subsequently asked for an *exact* solution.

NOV 1 We begin this month's fare with a chess problem from Steve Slesinger.

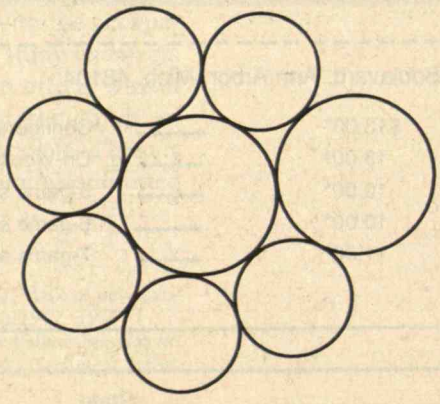


White, who moves down the page, is to move and win.

NOV 2 Thomas Mahon wants to know all positive integer solutions of $A^2 + (A + 1)^2 = C^2$.

NOV 3 Erwin Strauss (who claims to have been known as "Filthy Pierre" while at M.I.T.) offers us a problem in tennis theory:
In tennis, to win a game you must meet two conditions: a) win four or more points, and b) win two more points than your opponent — thus (dispensing with the fancy terminology of tennis scoring) winning scores are 4-0, 4-1, 4-2, 5-3, etc. If one player's probability of winning any given point is p, what is his probability of winning any given game? If winning a set requires winning at least six games, and at least two more games than your opponent, what is this player's probability of winning any given set?

NOV 4 The following problem is from Emmet J. Duffey:
The figure as shown at the right has been divided into five similar trapezoids by drawing lines parallel to the base. What are the heights of the trapezoids?



NOV 5 Dave Rabinowitz is interested in English words in which consecutive letters appear alphabetically. An example with two consecutive letters is "k*no*w." But "t*on*" is not valid as the "o" and "n" are out of order. What is the best word you can find — i.e., the largest number of consecutive letters?

Speed Department

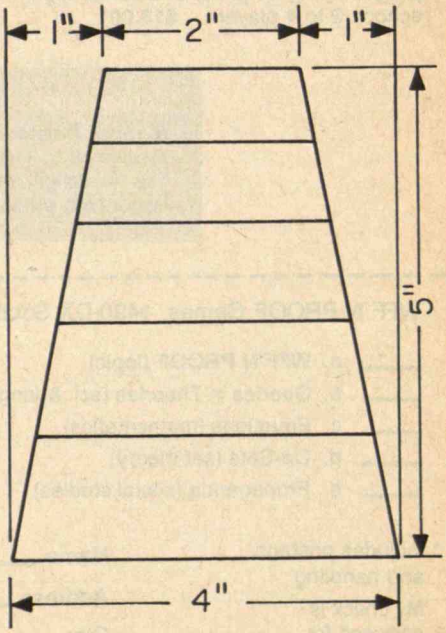
NOV SD 1 Our first speed problem is from R. Crandall:
The hour, minute, and second hands of a clock are *all three* coincident at noon and at midnight. Is this true at any other time(s) of the day?

NOV SD 2 We close with a quickie baseball problem from Mark Astolfi:
In a nonforfeited, nonsuspended, nine-inning baseball game, what is the *smallest* number of runs a team could score given that there exists a player "X" such that X is a member of the team and X gets to bat in all nine innings?

Solutions

The following solutions are to problems published in the June/July issue.

JUN/JUL 1 In the problem as published, we gave North only 11 cards. Please give North the ♥3 and ♥2 as well and try again. The solution will appear, with those for the November problems (*above*), in the March/April issue. The correct statement of JUN/JUL 1 is at the top of the next column:



♠7 3
♥Q J 3 2
♦5 2
♣A K 5 3 2

♠A Q 2
♥A K 7 6 5 4
♦A Q
♣J 6

With South the declarer at six hearts, West leads the ♥10. South thinks a moment or two and plays a heart from the dummy. East discards a diamond. What is the best play to make six hearts? If possible, supply the probability of success.

JUN/JUL 2 Part way along the 25 miles from Aardvark to Zymurgy, I begin to cross a railroad bridge. When I have gone three miles along the bridge, I hear a diesel train leaving the Aardvark station. I could exactly escape the train by running to either end of the bridge. But instead I cross over to the other track and walk four miles further. Now I see a steam train leaving the Zymurgy station on my track. Again, I could exactly escape by running to either end of the bridge. But instead, since the diesel train has just passed, I switch back to the first track. I reach the end of the bridge just as the steam train reaches the start of the bridge (in my direction). One hour later I reach Zymurgy. How long is the bridge?

The following solution is from Irving Hopkins:
There are six unknowns:

L, length of bridge, miles
a, distance from Aardvark to bridge
v, walking speed, m.p.h.
R, running speed
V, speed of diesel
W, speed of steamer

The six equations derived from the given information are:

$a/V = 3/R$ (1)
$(a + L)/V = (L - 3)/R$ (2)
$(25 - a - L)/W = (L - 7)/R$ (3)
$(25 - a)/W = 7/R$ (4)
$(25 - a)/W = (L - 7)/V$ (5)
$a + L + v = 25$ (6)

Dividing (2) by (1), we eliminate V and R and get $a = 3L/(L - 6)$. (7)
Dividing (3) by (4), we eliminate W and R and get $(25 - a)/(25 - a - L) = 7/(L - 7)$. (8)
Substituting (7) in (8), we get the quadratic $29L^2 - 500L + 2100 = 0$ (9)
from which L = 10 or 7.2413793.

The full list of parameters is *(see the list at the top of the next column)*:

L	7.2413793	10
a	17.5	7.5
v	0.2586207	7.5
R	7.5	17.5
V	43.75	43.75
W	8.0357146	32.75

Choosing L = 10 seems reasonable, except perhaps for the extreme demands on the pedestrian.

Also solved by Danny Mintz, Raymond Gaillard, Winslow Hartford, Andrew Purbrick, Douglas Szper, Avi Ornstein, Gerald Blum, Mike Bercher, Richard Kandziolka, Jacob Bergmann, Yale Zussman, William Butler, John Sutton, Alan LaVergne, Frank Rubin, John Rule, Neil Hopkins, Norman Wickstrand, and Richard Shetron.

JUN/JUL 3 Solve the following pair of equations for x and y:

$1 - xy = x + y^2$
$1 - xy = y + x^2$

Carl King had little trouble with this: At first glance, you might think these interesting equations were independent and related to the conic sections, but you would be wrong on both counts. Closer inspection reveals that they are symetrical, i.e., interchanging x and y in one equation produces the other. Hence any property that we discover of one can be translated to the other by interchanging the variables.
Rearranging the first equation we have:

$$xy + x + y^2 - 1 = 0$$

which can be factored:

$x(y + 1) + (y - 1)(y + 1) = 0$

hence: $y + 1 = 0$

and: $x + y - 1 = 0$ (1)

So, the equation turns out to be not a curve, but the product of a pair of linear equations.
The second given equation, by symmetry, gives:

$$x + 1 = 0$$

and: $y + x - 1 = 0$

which, in turn, is equivalent to: $x + y - 1 = 0$. (2)

Equations (1) and (2) are identical. Thus the two given equations are equivalent to just three linear equations, one of which is a polynomial factor common to both of them; whereupon the required "solutions" correspond to the infinite set of points on the line defined by the said linear equation, as last displayed above. In addition to that infinite set, there is a particular solution, which is at the intersection of the two dissimilar equations, occurring at x = −1 and y = −1. A small sample of points that also satisfy the given equations includes:

x	y
−1	+2
− ½	+1½
0	+1
+ ½	+ ½
+1	0
+1½	− ½
+2	−1
+2½	−1½
etc.	etc.

Also solved by Jordan Wouk, Robert Creek, Karl Pfeifer, Herbert Fox, Richard Shetron, Jack Parsons, Edwin McMillan, Alfred Emslie, Norman Wickstrand, William Stein, Charles Beer, John Prussing, F. Steigman, Raymond Gaillard, Will Liddel, William Hartford, Andrew Purbrick, Douglas Szper, Avi Ornstein, Gerald Blum, Mike Bercher, Richard

Kandziolka, Jacob Bergmann, Yale Zussman, William Butler, Alan LaVergne, John Sutton, Frank Rubin, John Rule, Irving Hopkins, Robert Granetz, Merrill King, Ray Kinsley, Emmet Duffy, Harvey Elentuck, Allan MacLaren, Everett Leroy, Sidney Kravitz and the proposer, Eugene Sard.

JUN/JUL 4 Find the telephone number with the following property:

myphone = (my)*(hy)*(p)^4.

Each letter represents a different digit (none repeats), and neither of the first two digits can be 0 or 1 (it's a telephone number, remember).

Several readers programmed computers to do exhaustive searches, and everyone agrees that the unique answer is 2374589. Emmet Duffy found this solution (and showed uniqueness) without a computer and his solution is reprinted below. First, here is a comment from Dennis Sandow which was written on A.T. & T. stationery:

You unnecessarily constrained the problem by suggesting that M and Y ≠ 0 or 1. By your rule, an Area Code could accommodate 640 (8 × 8 × 10) exchanges. As that limit is approached, the Area Code must be split into two. Half the subscribers in the Area Code (state, etc.) get a new Area Code. This last occurred in Virginia in 1973. The process of splitting Area Codes unsettles customers and may cause dialing problems for customers outside the affected area who "don't get the word." As a result, the Bell System decided to "unblock" the second digit of the exchange number. This adds 160 (8 × 2 × 10) more exchanges in each Area Code. These new exchanges are used only after the first 640 exhaust, because they could be confusing to some customers (with a 0 or 1 in the second digit, they look like an Area Code). The first such code was authorized in early 1974. As of mid-1978, there are about ten exchanges in service — all in Los Angeles (Area Code 213). Running the problem without that constraint doesn't change the answer. No solution is found when Y = 0 or Y = 1.

Mr. Duffy's solution follows:
If myphone = (my)*(hy)*(p)^4, then dividing by my will result in 100,000 + phone/my = (hy)*(p)^4. As phone cannot be larger than 98765 and my cannot be smaller than 23, the maximum value of phone/my is 98765/23 or 4293. Then (hy)*(p)^4 will equal a number greater than 100,000 but not over 104293. There are only 5 cases as shown:

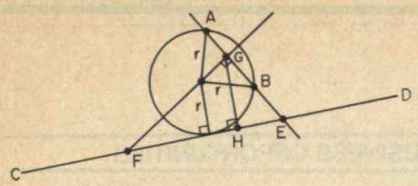
p	p^4	hy	$(hy)(p^4)$
8	4096	25	102400
7	2401	42	100842
7	2401	43	103243
6	1296	78	101088
6	1296	79	102384

The number 102400 can be eliminated as multiplying by any number will result with double zero at the end. For the other 4 cases multiplying by the possible values of my gives only one correct answer: myphone is 2374589, which is (23)*(43)*(7^4).

Also solved by Steven Radtke, Andrew Purbrick, Joseph Bergmann, Yale Zussman, William Butler, Alan LaVergne, Robert Granetz, Richard Shetron, Merrill King, Neil Hopkins, Ray Kinsley, John Sutton, Timothy Maloney, and the proposer.

JUN/JUL 5 Given a line and two points on one side of the line, construct the smaller circle which passes through the points and is tangent to the line.

Ray Kinsley finds the radius, r, of the required circle algebraically. But the formulas which result are all geometrically constructable. Note that the arbitrary points A and B on his arbitrary circle are to be the points mentioned in the problem:
The following relationships must be established first. Construct a circle with arbitrary radius r tangent to line CD. Select two arbitrary points on the circle and label them A and B. Draw a line through A and B to intersect line CD and label the point of intersection E. Construct the perpendicular bisector of chord AB extending it until it intersects line CD. Label this point F. Label the midpoint of the chord G and the angle between line CD and line FG label ϕ. Construct perpendiculars to



line CD that pass through 1.) the center of the circle and 2.) point G. Define the angle between this latter perpendicular and line GE to be ϕ and define the point of intersection of this latter perpendicular with line CD to be H. Define the length of line GB to be L/2 and the length of line GE to be a. Draw radii from A and B to the center of the circle. It can be proven that $\theta = \phi$ because triangle HFG is similar to triangle GHE. Also, from the figure it is seen that:

$$\text{Tan } \theta = (L/2 + a)/\text{length of line FG} = (L/2 + a)/[\sqrt{r^2 - (L/2)^2} + r/\sin \theta].$$

$$\text{Sin } \theta = \sqrt{r^2 - (L/2)^2} + r = \cos \theta\,(L/2 + a) = \text{length of line HG}.$$

From here on, let the length of line HG be given as K. Then

$$\sin \theta \sqrt{r^2 - (L/2)^2} = K - r$$

$$r^2 \sin^2 \theta - (L/2)^2 \sin^2 \theta = K^2 - 2Kr + r^2$$

$$O = (1 - \sin^2 \theta)r^2 - 2Kr + (L/2)^2 \sin^2 \theta + K^2$$

$$r = (2K \pm \sqrt{4K^2 - 4(\cos^2 \theta)(L/2)^2 \sin^2 \theta + K^2)}/(2 \cos^2 \theta)$$

$$r = (K \pm \sqrt{K^2\,(1 - \cos^2 \theta) - (L/2)^2 \cos^2 \theta \sin^2 \theta)}/(\cos^2 \theta)$$

$$r = (K \pm \sin \theta \sqrt{K^2 - (L/2)^2 \cos^2 \theta)}/(\cos^2 \theta).$$

The problem now is to construct:

$(L/2) \cos \theta$; $\sqrt{C^2 - B^2}$, given C and B; $K + A \sin \theta$, given A; and $N/\cos \theta$, given N. If you have followed the solution this far, the rest should be trivial. Having found a length r, two arcs from the two given points will determine the center of the required circle.

Also solved by Vera Granlund, Floyd Kosch, Arthur Hovey, Raymond Gaillard, Norman Wickstrand, Everett Leroy, Allan MacLaren, Harvey Elentuck, Irving Hopkins, John Rule, Frank Rubin, Emmet Duffy, William Butler, Alan LaVergne, Andrew Purbrick, Paul Mailhot and the proposer, John Gray.

Better Late than Never

PERM 2 Up to 170 we need solutions for 87, 93, 107, 157, 163, 166, and 167. The object is to create these numbers using the minimal number of arithmetic operators, ! (factorial), $\sqrt{}$ (square root), and . (decimal point). I am pooling the responses from Harvey Goldman, Harry Hazard, Harry Zaremba, Morrie Gasser, and George Ropes. Here are solutions from 171 to 200. Since interest has waned, this may be the last installment printed.

Let $Z = \sqrt{\sqrt{\sqrt{(.\sqrt{4})}}} ** (-4!) = 125$

171		186	$[(4 + \sqrt{4})! + 4!]/4$
172	$44 * 4 - 4$	187	
173	$Z + 4! + 4!$	188	$4! * 4 * \sqrt{4} - 4$
174	$44 * 4 - \sqrt{4}$	189	$\sqrt{\sqrt{\sqrt{4}}} ** (4!) + Z$
175	$[(4! + 4)!.4]!.4$	190	$4! * 4 * \sqrt{4} - \sqrt{4}$
176	$[(4 + /4)!]/4 - 4.$	191	
177		192	$4! * 4 + 4! * 4$
178	$44 * 4 + \sqrt{4}$	193	
179	$[(4 + \sqrt{4})! - 4]/4$	194	$4! * 4 * \sqrt{4} + \sqrt{4}$
180	$44 * 4 + 4$	195	
181	$[(4 + \sqrt{4})! + 4]/4$	196	$4! * 4 * \sqrt{4} + 4$
182	$[(4 + \sqrt{4})!]/4 + \sqrt{4}$	197	
183		198	$\sqrt{4} * 4!.(4!) - \sqrt{4}$
184	$[(4 + \sqrt{4})!]/4 + 4$	199	$[4! + 4! - .(4!)]!.(4!)$
185	$Z + 4!!.4$	200	$(4!.4) * (4! - 4)$

Proposers' Solutions to Speed Problems

NOV SD 1 No. The hour and minute hand are coincident at n:5n:5n/11; but a quick check shows that the second hand is nowhere in sight at these times.

NOV SD 2 Zero runs. Here is one way to could work out: let "X" lead off. In the first inning, X, batter 2, and batter 3 load the bases; then batters 4, 5, and 6 strike out. No runs scored. In the second inning, batters 7 and 8 strike out. Number 9 gets to first, but while X is batting 9 is either picked off base or is out trying to steal. No runs scored. Now, since X was at the plate when the third out of the second inning was made, X must lead off the third inning. Thus, the third proceeds as the first inning, the fourth as the second, etc. X comes to bat in each inning, and no runs are scored.

Classified

PROFESSIONAL

WHEN YOU NEED HELP GETTING HELP

In any technical field, call (215) 735-4908. We have been placing carefully selected engineers, chemists, scientists, metallurgists and technical sales people in all fields since 1959 . . . and we can do the same for you.

No charge unless we fill your position. Over 1000 client companies count on our technical staff for help. You can, too. Call today, or request our new brochure.

A. L. Krasnow, '51, Pres.

ATOMIC PERSONNEL, INC.
Suite T, 1518 Walnut St., Phila., Pa. 19102
An Employment Agency for All Technical Fields

WE ARE CONSTANTLY SEARCHING FOR:

- Engineers: EE's, ME's, CHE's
- Scientists
- Computer Professionals
- MBA's
- Financial Specialists

Submit your resume and salary history to:

Martin Lyons Personnel Services, Inc.

234 No. Main Street
Mansfield, Mass. 02048
(617) 339-9301
714 Washington Street
Norwood, Mass. 02062
(617) 762-4100

You're Boxed In

Your career is blocked. You're frustrated and insecure. Time is going by and things aren't getting better.

You need to find a better way. You need new objectives for yourself and new strategies for achieving your objectives.

That's my job. I am a management consultant, specializing in change, and I have helped hundreds get out of that box and onto a more satisfying career and life path.

Write for free brochure T11, "Get Out of that Box — Now!", or telephone for an appointment. Don't wait. Do it now.

Riva Poor, SM in Management, and MCP, from MIT

Private programs. Also 2-day weekend workshops. *(See p. 3 for details.)*

Riva Poor Associates
73 Kirkland Street
Cambridge, Ma 02138
Telephone: (617) 868-4447

CURRENT OPPORTUNITIES

- Program Mgr. Sig. Processing $35,000
- Program Mgr. Millimeter Wave Radar $35,000
- Laser Radar Tracking/Pointing $35,000+

. . . and many more challenging opportunities
Call or Write:
Barry Gruber

JUDGE
ELECTRONICS SERVICES INC.

Personnel Services
Suite 100, Two Newton Executive Park
Newton Lower Falls, Ma 02162
(617) 965-9700

HOW TO EARN MONEY AS A CONSULTANT
(including specimen contracts) $31.
Business Psychology International
890/13 National Press Bldg., Washington, D.C. 20045

GRAPHS drawn by exp. artist for publication in med. and sci. journals. $15/hr. Will pick up, deliver in Boston area. References. Wendy Skinner, Danvers, MA 617-774-5256 MWF

WE ARE SEARCHING FOR:

Engs. and Scis: Opts, Mech., Sys., C/S, Materials, Device Lithography, Adv. LSI Proc., Pro. Mgrs. and Techs. Call (703) 671-0010, Professional PSP, Search Personnel 4900 Leesburg Pk., Pike, Alexandria, Va. 22303 (Lic.)

MANAGING EDITOR for this magazine. Background in science and/or engineering with considerable experience in writing, reporting, and editing in these subjects and in publications management. Technology Review, Room 10-140, M.I.T., Cambridge, Mass. 02139. (617) 253-8251.

PUBLICATIONS

ARE YOUNG ENGINEERS IMPORTANT TO YOUR COMPANY'S FUTURE?

You can tell them about your products and opportunities today . . . on over 50 campuses . . . thru the pages of their own **Engineering College Magazines**

Littell-Murray-Barnhill, Inc. National Advertising Representative, 1328T Broadway, New York, N.Y. 10001

MARTIAN SUNSET, LUNAR EARTHRISE

Genuine NASA Viking & Apollo high-quality FULL COLOR ART PRINTS: 22" × 34" Ideal for permanent framing & display. Beautiful. $10.95 each plus $2.05 insured postage.

WOODSTOCK PRODUCTS
P.O. Box 4087, Dept. TR3, Beverly Hills, CA 90213

DRUGLESS SINUS RELIEF
Finally, an easy-to-use treatment you can use at home or in the office. It relieves congestion, ends stuffiness almost immediately. Send $1 for details. HydroMed, Dept. TM, 1763 Vista Del Mar, Los Angeles, CA 90028

BUSINESS OPPORTUNITIES

SYNTHETIC LUBRICANTS

Auto — Commercial — Marine — Farm

Direct sales dealership. Retail/Wholesale basis. Full line of 100% pure ester base lubricants from the nationwide leader. No quotas. Start part-time, build to full-time.

Respond to
L. DeMaio, 12 Marmor Ct., Wethersfield, Conn. 203-563-0880 or
to R. Cabacoff, 255 North Rd., Chelmsford, Mass. 01824 617-256-7788

REAL ESTATE

LINCOLN, MASSACHUSETTS
Contemporary home on unique 4-acre site with spectacular western panorama. Master suite and 3 bedrooms, each with bath. Brochure, A/V preview available. Excl MLS $225,000, Concord Junction R.E., 129 Commonwealth Ave., Concord, Mass. 01742 (617)369-9435

CAPE COD: FALMOUTH
Waterfront weathered shingle year-round Cape. Sea, Sand, sunshine. Windswept beach. Bach R.E. (617)540-0707

EVERETT, MASSACHUSETTS
In newly renovated building, 1,200 sq. ft. Large reception area and four individual newly decorated offices. Ideal for an engineering firm. Call Miss Brodowski 617-943-2319 or write Box 1227, Marshfield, Mass. 02050

GROTON, MASSACHUSETTS

A lovely, small town and 25 minutes to Route 128

1898 BRICK HOUSE, 12 rooms, 40 acres, huge terrace, magnificent views, three-car garage, small stable, peach orchard, pond frontage, $189,000.

BEAUTIFULLY MAINTAINED antique house, 14 rooms, 12 fireplaces, 5½ acres with barn/garage and rental apartment, Historic District, business zoned, $135,000.

IMPRESSIVE CONTEMPORARY, 10 rooms, huge, mahogany-panelled living room, 32-foot kitchen, screened and open decks with delightful views. Eighties.

MRS. MAYNARD RENNER, REALTORS
(617) 259-9222

Classified Ads: $3.00 per line; two-line minimum. (Allow 32 letters & spaces for first line; 50 letters & spaces for each additional line.)

Display Ads: $25.00 for first column inch; $20.00 for each additional inch.

Copy Deadline: one month prior to publication date. Payment in advance of insertion required for less than three insertions in one year. Send orders to Classified Section, *Technology Review*, M.I.T., Room 10-140, Cambridge, Mass. 02139.

A New Source of Old Oil

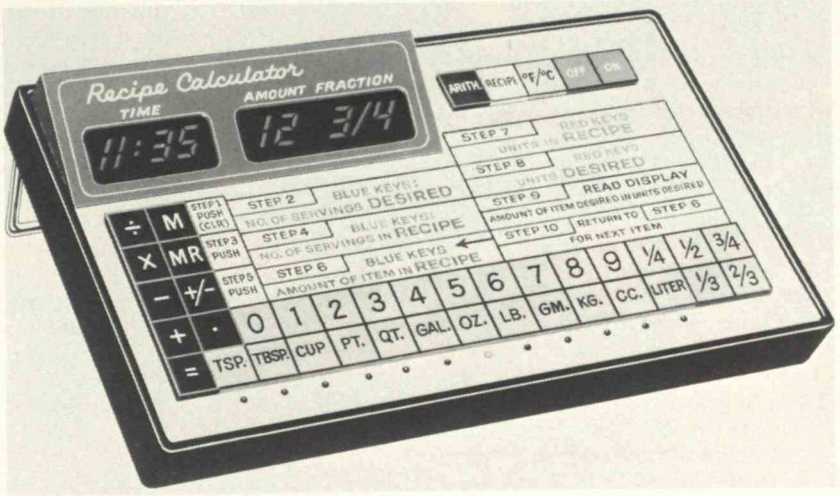
There remains no shred of doubt about plate tectonics, the idea that the earth's surface consists of crustal plates in constant motion, drifting like rafts across the planet at the rate of a few centimeters a year, regenerated by hot magma welling up through fissures in the oceans' depths and destroyed as their edges slide against each other in the major earthquake zones.

In hardly more than a decade, this idea has revolutionized geology and the search for mineral resources. Now it is also the source of expectations of a whole new class of ancient fossil resources.

Sedimentation patterns in the North Atlantic are consistent with every other evidence of plate tectonics and sea-floor spreading: the sediments are thinnest above the mid-Atlantic ridge where the plates on which we live are being formed; and they are thickest above the oldest rocks, farthest from the ridges, in the abyssal plains along the continental shelves of the U.S. and Europe. It's now possible, thanks to ambitious programs of drilling into these sediments in the last five years, to track the exact movements of the continental plates under the North Atlantic since the ocean formed. Now Professor John G. Sclater and his colleagues in the Department of Earth and Planetary Sciences at M.I.T. have used this data to reconstruct the history through time of the North Atlantic sediments — the accumulation of wastes and remains from oceanic life during the past 165 years.

Especially Professor Sclater wanted to understand the pressures and temperatures to which these ancient organic materials had been exposed in the course of their long journey across the floor of the sea. His reasoning is simple: organic residues in sediments are transformed into hydrocarbons by heat and pressure. It is precisely such a process that has transformed the remains of relatively modern plant and animal life into the oil and gas we use today.

Have the right conditions prevailed at the bottom of the Atlantic Ocean? They have indeed, Professor Sclater told a Technology Day audience at M.I.T. last summer. Sediments at depths of 4.5 to 5 kilometers may well have been turned to hydrocarbons during the past 100 to 200 million years — a new reserve of fossil fuel lying beneath the sea beyond the continental shelves. If Professor Sclater is right, exploitation awaits only the technology for drilling holes three to four miles deep through mud and rocks lying under 15,000 to 18,000 feet of water. □



Handy Dandy Kitchen Computer

Your recipes make four servings, but you're having nine guests for dinner and you're having trouble taking 9/4ths of every teaspoon, ounce, and cup? And, to make it worse, your most exotic recipe is in liters, but all you have in the house is a measuring cup?

You need Professor Ascher H. Shapiro's kitchen calculator.

Professor Shapiro, who teaches mechanical engineering at M.I.T., is a specialist in biomaterials and such engineering processes as fluid flow in the human body. Cooking isn't even his avocation. But he's just been granted a patent on the principle involved in a "recipe calculator" such as the prototype shown above, and he hopes soon to have his solid-state computer ready for the millions of nonmathematical cooks in America's kitchens.

A Birth-Defect Computer Offers Diagnosis by Phone

Some 1,400 specific birth defects have been identified; some are common and easy to recognize, but some occur only once in 25,000 births — or once in the career of an average pediatrician. Yet diagnosis is crucial to effective management and treatment.

A computerized data bank now contains information on the symptoms of most birth defects, and doctors throughout the U.S. can reach it through their dial telephones. In a few moments' time they can compare their observations with the classical clinical manifestations, ending what has often been "a desperate guessing game" in hospital delivery rooms.

The computer system is the product of John J. Donovan, Associate Professor of Management Science at M.I.T.; and the data recorded in it have been assembled and weighed under the direction of Dr. Daniel Bergsma, Chairman of the Management Committee of the Center for Birth Defects Information Services, and Dr. Sidney Gellis, Chairman of the Department of Pediatrics at Tufts School of Medicine. It's a project of the National Foundation — March of Dimes, which is funding it at the rate of $450,000 annually.

By the end of this year, the National Foundation expects to have at least one computer terminal in each of the 50 states with full access to the Boston-based computer, and it will be possible to dial into the system from anywhere in the U.S. and Europe.

At a press demonstration early this summer, Dr. Gellis explained that birth defects are "becoming more and more important as a part of pediatric practice. . . . Clearly no one doctor can carry enough information around in his head to know what to do when a rare birth defect turns up."

And if the computer is presented with a set of symptoms it can't identify, specialists will be called in and may in fact provide early warning of environmentally-triggered problems. "Another thalidomide disaster would be prevented," thinks Dr. Gellis. □

Management Information Systems

How will tomorrow's management information systems work for executives and the companies they serve? What new trends in computers and data systems promise greatest future benefits? How should a company plan now to capitalize on these advantages?

Members of the M.I.T. faculty will be among experts answering such questions at a symposium sponsored by the M.I.T. Alumni Center of New York on Thursday, December 7. Information and reservations for the full-day program on "Information Systems: New Perspectives for Management" at the New York Hilton are available from the Center at 50 East 41st. St., New York, (212) 532-8181; the price, including luncheon and cocktail reception, is $100.

Tracing a Man-Made Carcinogen

"New" sediments — those deposited since about 1850 — on the floor of Buzzards Bay, south of Massachusetts, show traces of polycyclic aromatic hydrocarbons (P.A.H.), products from the combustion of wood and coal which are believed to be carcinogenic in man. Old sediments, from 1850 and before, show none.

His data convince Ronald A. Hites, Associate Professor of Chemical Engineering at M.I.T., that polycyclic aromatic hydrocarbons have been settling into Buzzards Bay only since the widespread use of wood and coal. That's a worrisome finding, he says. If P.A.H.s had been in the atmosphere originally, then man might be expected to have developed a tolerance to them. But such tolerance could hardly have developed in a period as short as 100 years; and in fact man may have no tolerance for the carcinogenic effects of P.A.H. at all.

Three Experiments on Pioneer Venus

Pioneer Venus 1 and 2 spacecraft are operating normally, "right on course for Venus," as this is written in August. Three M.I.T. experiments are on board:

☐ Gordon H. Pettingill, Professor of Earth and Planetary Sciences, will couple radar mapping data on Venus with information on its gravity, trying to correlate surface and gravitational features.

☐ Irwin I. Shapiro, Professor of Geophysics and Physics, is in charge of a celestial mechanics experiment from which should come the most accurate measurements yet of the orbit of Venus.

☐ Professor Charles C. Counselman will measure the effect of Venus' atmosphere on one of the four probes which will be launched from Pioneer Venus 2. He will determine the probe's position and movements with great accuracy using a "long baseline interferometer" composed of four radio transmitters on four continents of the earth; from the probe's motions he will try to infer the directions and speeds of winds in Venus' atmosphere. ☐

Up and Down in New England

What forces dictate the ebb and flow of the New England economy? What factors dictate the investment decisions that determine economic activity, and how do workers respond? What is the effect on local government and on industries which do not migrate? And in turn how do actions of the public and of governments affect the investment decisions upon which prosperity or poverty depend?

Such questions are to be answered by a study of the New England economy now in progress in the Harvard-M.I.T. Joint Center for Urban Studies under the direction of Professor Bennett Harrison of M.I.T. A consortium of federal agencies concerned with commerce and labor is providing funding. ☐

Wanted: A Center for Housing Research

Despite extensive and increasingly specific research about urban living environments that work and those that don't, urban housing is deteriorating and the U.S. continues to lack directions in which to respond.

"The problem is, Who is listening?" says Sandra C. Howell, Associate Professor of Behavioral Science in the Department of Architecture.

The U.S. is the only industrialized nation in the world lacking a central research agency "responsible for continuous feedback on the habitability of living environments and systematic experimental programs in building technology." Such an agency is "essential to rational and humane planning for metropolitan living," she says.

Policy-planners in housing assume that supply and demand figures — the market system — tell them what is needed about family housing needs and wants. But what if nutritional experts relied on food marketing information to establish nutritional standards? asks Dr. Howell. ☐

Power Shortage in 1984?

Overregulation today may be paving the way for environmental disaster tomorrow, says Norman C. Rasmussen, Head of the Department of Nuclear Engineering at M.I.T.

If electricity demand continues to grow at recent rates — 6.3 per cent in 1976 and 6.5 per cent in 1977 — the U.S. will need 200 new 1,000-Megawatt generating plants by 1985, he says. They're not yet on the drawing boards, and — with 40 to 50 licensing procedures required in addition to construction time — it's hard to bring a new coal- and nuclear-powered plant on line in less than 12 years.

Professor Rasmussen's fear is that a shortage of power in the 1980s will lead to a "crash program" for new development in which "concern for the environment may be forgotten entirely." He concludes that "the pendulum has swung too far in regulation and licensing — and it has done so at the expense of the public."

No Nuclear Threat from Japan

Were the Japanese about to build their own atomic bomb when the U.S. ended World War II by destroying Hiroshima and Nagasaki?

Categorically no, says Charles Weiner, Professor of the History of Science and Technology at M.I.T. No threat from the Japanese could have been used to justify U.S. use of atomic weapons — or the later destruction by the U.S. of five Japanese cyclotrons late in 1945. "In no way was there any nuclear arms race with Japan," he says.

"The Japanese did not have the capacity to make an atomic bomb during the war. . . . Japanese physicists, like those in many other countries, explored the feasibility of developing such a weapon. The Japanese came to the conclusion that it was not possible to achieve during the war," Dr. Weiner wrote the *New York Times* early this year, seeking to clarify an earlier report in *Science*. ☐

When E.F. Hutton talks, people listen.

Mapping fuel savings through improved traffic flow.

More miles per gallon . . . or rather, kilometers per liter. That's been the objective of many programs here at the General Motors Research Laboratories.

One of these concerns urban traffic. Our scientists have conducted studies to determine which traffic variables have the greatest effect on gasoline consumption, and how much fuel could be saved through improved traffic flow.

They began by driving instrumented cars in traffic at different levels of congestion. From a detailed multivariate analysis of the data, they found that a car's fuel consumption in city traffic was related simply and linearly to average trip time (see equation).

$$F = A + BT$$

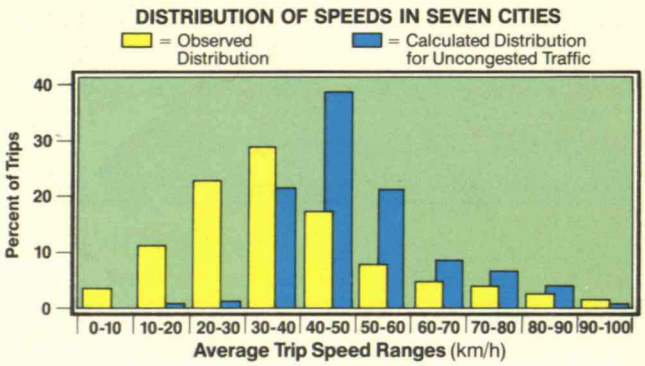
(valid up to ~ 60 km/h)

- **F** = fuel consumed per unit distance
- **A** = constant related to average vehicle mass
- **B** = constant related to average idle fuel flow rate
- **T** = average travel time per unit distance

Confirmed in traffic experiments, this relationship suggests that drivers would use less fuel if traffic conditions permitted higher average trip speeds, thus shortening trip times.

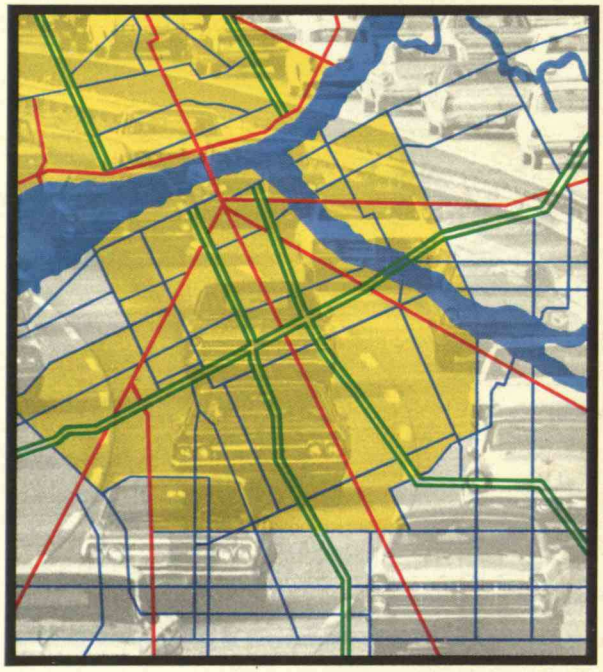
What order of fuel savings could be expected?

An analysis was made of trip-speed data collected by GM in Chicago, Denver, Detroit, Los Angeles, New York, San Francisco, and Washington, D.C. Two results: If traffic flow improved so no trip averaged less than a modest 24 km/h (15 mph), a 2.5% fuel saving would result. If the average of all trip speeds equaled that attained in uncongested traffic, 13% would be saved (see graph).



Our scientists also developed and validated a computer model to predict travel times throughout a complicated road network. It enables researchers to estimate fuel savings from traffic engineering improvements, car-pooling, staggered work hours, etc.

Traffic research: Driving toward better fuel economy and a more pleasant trip for you.



GM

General Motors Research Laboratories
Warren, Michigan 48090

We currently have openings for Ph.D.s in engineering or the physical, mathematical, or biomedical sciences. If interested, please send your resume to: GMR Personnel, Dept. 1116. An Equal Opportunity Employer.